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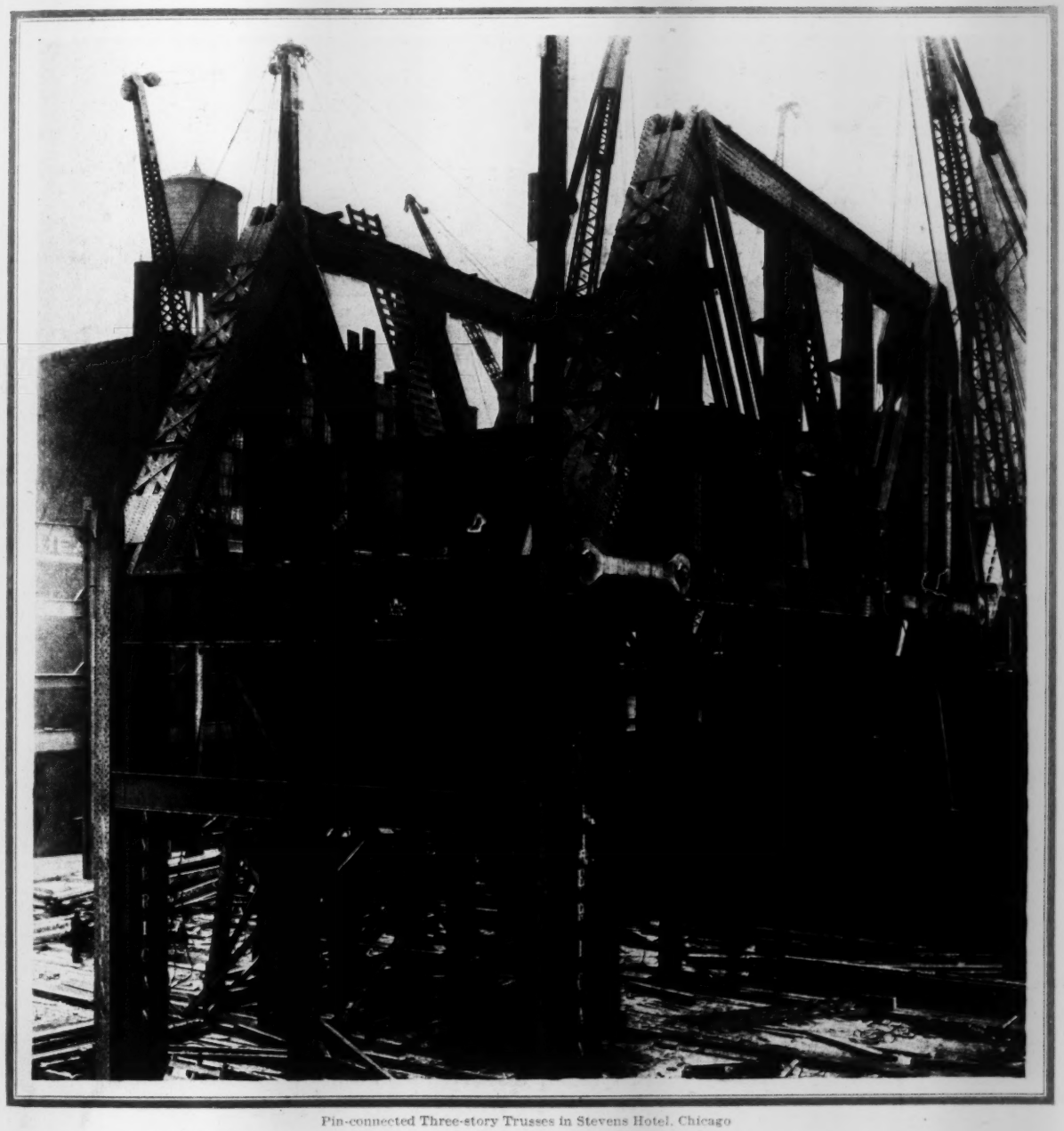

Pin-connected Three-story Trusses in Stevens Hotel, Chicago

Steel Trusses Carry Twenty-two Stories in Chicago Hotel—Tunnel Taps Mystic Lake Below Water Level—Lime-Silica Index as a Measure of Cement Quality—Staff Report of American Society of Civil Engineers Spring Meeting

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 96 NEW YORK, APRIL 22, 1926 Number 16

Competitive Research

A NEW theory of engineering research is advanced by the Texas congressman and senator who would divert one-quarter of one per cent of all federal road funds to the Corps of Engineers for highway research. As the note in the news section (p. 666) reports, the congressman wants to have a little competition between the government agencies. He thinks that the Bureau of Public Roads isn't learning quite as much as it should about nature and nature's laws as applied to highways so he would set the army engineers to work testing and experimenting. Probably the first bureau that produces a consistent 4,000-lb. concrete with a 6-sack yard will get an extra $5,000 for its next year's appropriation and the laboratory that shows the least wear on a test road surface will have the honor of being called the official federal research bureau for a year. It's a great idea that might be carried into all branches of government activity. It is a pity, therefore, to have to record that Washington hears that behind the bill lies the resentment of a politically powerful Texas engineer at the Bureau of Public Roads' lack of interest in his patented track as a highway substitute. Pique, not scientific curiosity, is the motive.

Road Reconstruction

A PORTENT of the future in road building comes from Connecticut, one of the early states to begin improvement. Connecticut has 1,400 miles of trunk line highway. If pace is to be kept with traffic, all of this mileage, says the highway commissioner, will have to be reconstructed in the next ten years. This work it is estimated will cost all of seventy million dollars including no additional mileage and including no improvement of bridges. These figures appear stupendous but there can be no thought that they are excessive. Indeed the cost is more likely to have been underestimated than to be exaggerated. If an old and populous eastern state whch has been building modern roads for upwards of thirty years and which is commonly regarded as having completed its pioneering in road building has yet ahead of it so great a task, where are the limits to future investment in public roads? Any quantitative estimate is absurd. Virtually there is no limit to road building expenditures as long as automotive traffic continues to develop. Road building is a continuing process and gradually this thought is coming to all the people. All the glib assumptions of a few years ago of finished road systems and the reduction of taxes and special imposts and the disappearance of great federal and state road building departments have ceased. The fact is realized that they must continue and that road building must go on and that a plan of reconstruction must follow on the heels of the present building program. As Connecticut is planning so must every state, some at once, and all eventually.

No More Missouri Road Bonds

MISSOURI is unusual among the states which have in the last few years built roads on bond issues, in deciding not to go further into debt but to depend on current income for highway improvement. Illinois the leader of the present roadbuilding era in big highway bond issues has added $100,000,000 to the original $60,000,000; Pennsylvania has added $50,000,000 to its first $50,000,000 and North Carolina has increased its original $50,000,000 by $15,000,000 and then $35,000,000. Most exceptional, however, is the fact that the action in Missouri to issue no more road bonds has been inaugurated by the State Highway Commission. On April 13, the commission adopted a resolution against any further state road bond issues "after the present $60,000,000 issue is exhausted." Concurrently it pointed out that by 1934 the present 7,640-mile state system of roads could be completed from current income and cited the amounts of that income ranging from $10,000,000 in 1928 to $14,000,000 plus in 1934. Among public roads authorities there will be both agreement and disagreement with the wisdom of the action of the Missouri commission. We may not consider the opposing arguments, though the situation in Connecticut, indicated in the preceding note, should show Missouri that a system of roads is never completed. The fact of moment to be regarded from the Missouri decision is that moderation is not a lost attitude of mind even with official road builders in an era of unparalleled income for their uses.

Growing Complications

A HIGH level of complications in structural steel framing is reached in the Stevens Hotel, described in this issue. The maze of truss and girder work is probably unprecedented in city building construction. Much of the upper part of the structure is carried over open spaces below, as a result of the architect's liberality in planning unobstructed halls and dining rooms. But the complication differs only in degree from that found in many other recent structures. In fact the present case is typical of the consistent trend of current practice, apparent in other recent theaters, hotels, and assembly buildings. Architectural imaginativeness with respect to interior planning is rising toward constantly higher and bolder levels—the boldness being furnished by the structural engineer. In this way the simple even-celled rectangular frame that grew up as standard with the development of skyscraper construction during 30 years is being transformed into a highly irregular network, and in the transformation it is invested with formidable difficulties and new structural questions. The design of steel building framework, which some years ago appeared to have fallen into a rather dry routine, is thereby again enlivened by problems engaging the highest type of engineering skill and judgment.

Even a superficial comparison of the Stevens Hotel framing with that of the ordinary loft building brings this into view, by making apparent the radical differences in the conditions governing strength and rigidity in the two types of structure. Practices which experience has shown to be amply sufficient and satisfactory in the ordinary type of building frame are not necessarily applicable to the complicated frame, and so a complete restudy of structural service and resistances is indispensable to safe design. Though the new demands thus are severe, they will exert a healthy influence on engineering practice, which has been in some respects in danger of becoming too much conventionalized and commercialized. At the same time, the steadily growing complication in building design suggests a look ahead, with the possibility in mind that complication may proceed so far as to introduce unsuspected hazards. After all, the omission of columns in a dining room may not be as necessary as architect and hotel man seem to believe.

Drawbridges as Time Wasters

GENERAL TAYLOR'S excellent letter on another page reciting the War Department's earlier rulings on the New Jersey drawbridge cases seems to us but to confirm our editorial contention that the Department is concerned primarily with defending the waterway. The Department's assumption, possibly backed by law but if so by law which finds its ancestry in medieval England, is that the river business is necessary and must be preserved; that seems to supervene an unbiased attempt to balance the transportation needs of the whole community. That the New Jersey cities should argue for the river before the Department is to be expected, for their consistent policy is to do anything and everything that will prevent easy commuting travel to New York, thereby hoping to drive business from New York to centers more readily reached from the residential suburbs. It may be noted, too, that any belief that a ten-minute limit for drawbridge opening means only a ten-minute delay for trains reaching the Hudson River terminals disregards totally the complications of suburban railway terminal operation, where during rush hours there is a train every minute for the best part of an hour and where the whole schedule depends on a nice synchronism of train arrival in and removal from the terminal. A ten-minute delay at the bridge not only may mean twenty minutes for the last train to be stopped, but also may subject that train to the possibility of being stopped again by the next opening of the bridge. We still contend that the railway traveler, who too frequently is confused with the railway itself, needs a friend in court.

Mussolini a City Planner

MUSSOLINI has ordained that the grandeur that was Rome be restored and has set about it. "Rome's birthday," April 21, officially marked the beginning of the work. However long it may take and however much it may cost for Senator Cremonesi, "the first Governor of Rome," to carry out the premier's order to make Rome again "as vast, well-ordered and powerful as in the days of Emperor Augustus" the 90,000,000 lire advanced by Italy will make a good start on the work. It ought not to cost much to clear away what are described in a New York *Times* dispatch as "the ramshackle houses and huts clustering around various ancient structures, which belittle the latter, and relatively little to remove modern buildings that detract from the Appian Way. Even under a dictator Rome can not be restored in a day, but some of the work can be done so quickly as to make an immediate showing. More time will be required for cutting the two proposed thoroughfares, one between the Trajan and Roman Forums and the other leading to the Colosseum. These new streets will have both utilitarian and aesthetic value, in that they will relieve traffic congestion and carry still further the work of bringing Roman monumental structures into view. The first named street will reveal the left flank of the Capitoline Hill and the second street will render the Colosseum, which now rises in the center of a saucer-like depression, visible from the center of the city. City planners may well grant the dictator honorary if not active membership in their associations, and when he gets through at home we might invite him to come over and see what he can do with Pennsylvania Avenue.

Engineers as Executives

IT IS a common enough impression that engineering training and practice unfit one for executive positions. Most business men like to think so; some bankers are so disposed; it will be remembered that Secretary Work obtained some notoriety a few years ago by rather violent expression of the idea. Even some engineers in their pessimistic moments are persuaded that it is true. The engineer, in this view, is an excellent specialist, a competent molder of material things, even a fair director of other men at work; but he is not the proper person to weave all of those parts into an effective whole in which money, materials and men all play their part. He lacks, they say, that elusive something known as executive ability.

Engineers as a class have resented this imputation. Not every engineer wants to be an executive; the management of large enterprises does not necessarily appeal to every man as the ideal activity of life. There is a personal happiness to be gained by pursuit of purely technical engineering activity which for some men far transcends the sense of power and the things accomplished that reward the successful executive. But every engineering activity has to be headed up by an executive and more of the world's activities are becoming manned by engineers, so that an engineer naturally resents the idea that his progress toward the top of his own ladder is limited by his own deficiencies. Just so far shall he go, say the critics, and no further. The top rungs are for other men.

And so, while disbelieving the premise, engineers are worried about the conclusion. Educators ponder over its effect upon their curriculum and industrial leaders discuss the product of the engineering school and its relation to industry. Speakers at engineering meetings wonder if there is not something inherent in the practice of engineering that disqualifies a man for industrial or business leadership. It is evident that a little common sense is becoming necessary in the consideration of the subject, and that common sense was very effectively applied at the joint meeting last week, in New York, of the four major engineering societies.

At that meeting, called to discuss the question of how

the engineer may be qualified for executive position, four of the most distinguished examples of the rise of the engineer to industrial leadership addressed an assemblage of engineers whose interest was evidenced both by numbers and sustained attention. The four men had no previous collusion as to what was to be said. Each, of course, drew largely on his own experience. They might well have come to widely divergent conclusions. The fact is that they agreed in the main and that this agreement seemed to be that there was considerably more excitement about the lack of executive ability amongst engineers than the facts warrant.

They agreed that in proportion to their numbers there probably were as many engineers in high executive positions in our industries as any other of the professions or avocations that enter the industry. They agreed that engineering schooling today is satisfactory and that while some more attention might be given to the generalities of culture and some more emphasis on the "fundamentals" that after all the main object of an engineering education was to make an engineer and that the industrial executive in a company concerned with engineering activities of any sort must be, as one of the speakers put it, "a mighty good engineer." They agreed finally that leadership in this world comes down to personal qualities, that those qualities may be held by any one, that the special training of the engineer leads, rather than the contrary, to qualities useful to the executive, but that the broader demands of personality and character—of resolution, of broadmindedness, of tolerance, of ability to get on with one's fellow man, of ability to inspire respect, of ability to generalize from a group of particularities, to give orders so they are understood, to decide quickly and in the main correctly—these qualities are not subject to development through the exercise of any special collegiate or professional training and that they reside in every man in greater or less degree waiting for his own cultivation. Not every man who has native ability cultivates it. Not every man who having it and cultivating it gets the opportunity to demonstrate his possession. Of the many who labor, only a few are called. Of the many who are called, few are chosen.

This is excellent doctrine that engineers would do well to ponder. We are hearing somewhat too often of late that engineers are congenitally deficient in executive ability. There has been too much of setting them off in a class of natural subordinates, of high-grade artisans, of educated mechanics, too much of the belief that because some engineers are wedded for life to mathematics, all engineers are slaves to the rigorous domination of equations. One cannot draw an indictment against a whole profession. Just as only a few men are qualified to become industrial leaders, so only a few engineers are qualified. If anything, the proportion is greater in the engineering profession than it is in any other profession or vocation, but that does not mean that all engineers are qualified to lead, nor even that the ultimate good demands that they all become leaders or executives.

It is probably true that the way to effective leadership is denied many engineers because of too stern an allegiance to the materialistic side of their profession. It is there that the engineer needs to take thought, if he is to destroy the impression that he is not fitted for leadership. It is possible, and the four speakers last week have demonstrated it in their persons, to be a "mighty good engineer" and still rise to executive eminence, and it is good for the world of business that a certain number of enginers do so rise. But the engineers who are so marked beyond their fellows are those who have cultivated natural qualities, quite dissociated from their engineering training, and have superposed those qualities on the qualities the engineering training developed. They are better executives because they are good engineers, but being good engineers did not make them executives.

Open Covenants?

AS THIS goes to press, international technical standardization is once more under discussion. A meeting of officials of national standardizing bodies has been in session in New York during much of the past week on this subject. The relation of the new movement to former ones, and to present industrial and commercial conditions, suggests interesting reflections. These are better deferred, however, until the outcome of the current deliberations is made known. In the meantime, it can be gathered that the matter is yet in its crude beginnings, as indicated by the fact that the proposal for an international standardizing organization emanated from one of the bodies represented in the meeting; that is, the call to larger responsibilities came from the officials who serve standardization rather than from the arts and industries served by it. Since standardization has no intrinsic virtue but derives its value wholly from its service to the world's work, it may be set down as a basic principle that art and industry should exhibit specific need of standardization before it is taken in hand, or it may prove a nuisance rather than a blessing. In the present case need of this kind has not been conspicuous.

In the absence of an obvious need it is noteworthy that the supporters of the proposal carry on their meetings behind closed doors, as if fearful of the light of day—this, too, after the meeting had been announced publicly, and presumably was intended as an open meeting, like that of any other technical society. While this star chamber diplomacy is not altogether out of line with some of the latter day internationalism, it seems particularly inept and obtuse in the present case. No one has a more direct concern in any move toward international standardization than the circle of technical men; a meeting to discuss whether or not such a movement—which is clearly of and for the technical community—shall be organized, and how it should be organized, is very much the business of technical men in general, and they can hardly be expected to give it support and adherence if managed as a private affair, behind closed doors. Incidentally, those who attended the meeting were not principals but were messengers; the real participants were the engineering and industrial societies of which the representatives of the several standardizing bodies are only the voting proxies. So long as the present spirit prevails, the prospects of making a useful start toward an international standardizing organization are not bright. But it is reassuring to reflect that if such an organization proves to be really needed, it is only a question of time when a more promising attempt toward setting it up will be undertaken.

Steel Trusses Carry 22 Stories in Chicago Hotel

Unsymmetrical Truss with Both Pin and Riveted Connections Designed to Meet Special Conditions — Steel Castings on Truss Pins Carry Columns—Small Trusses and other Structural Features

TRUSSES of 86-ft. span, three stories high, having both pin and riveted connections and carrying a superstructure of twenty-two stories, form a striking feature in the structural steel framework of the 25-story Stevens Hotel, now under construction in Chicago. As is usual with buildings of this class, the structural design is based upon the architectural plan and is thus complicated by many special difficulties and requirements. Most of the second floor area is assigned to ball, banquet, dining and lounge rooms, which must be clear of interior columns, so that heavy truss and girder framing is required to carry the heavy loads of intermediate columns above these open spaces. Over 350 trusses and girders were used in the 3rd, 4th, 5th and 6th stories, the majority of which carry columns.

A ball room space 175x84 ft. on the second floor, three stories in height, entirely clear of columns, was the principal problem. The solution was obtained by introducing the heavy trusses noted above, having their bottom chords just below the fifth floor and the top chords just below the eighth floor. There are four of these trusses, spaced about 35 ft. apart; each has a span of 86 ft. c. to c. of end pins and a depth of 31 ft. c. to c. of chords, and weighs 240 tons. Figs. 1 and 2 show the trusses erected; Fig. 4 is a plan showing the layout of these and smaller trusses.

In the space above this ball room and supported by these four large trusses, there are 55 interior columns. Some of these columns are carried directly on the trusses and others are supported by a system of auxiliary trusses and girders framed between the main trusses, as shown by Fig. 4 and the diagrammatic cross-sections in Fig. 3.

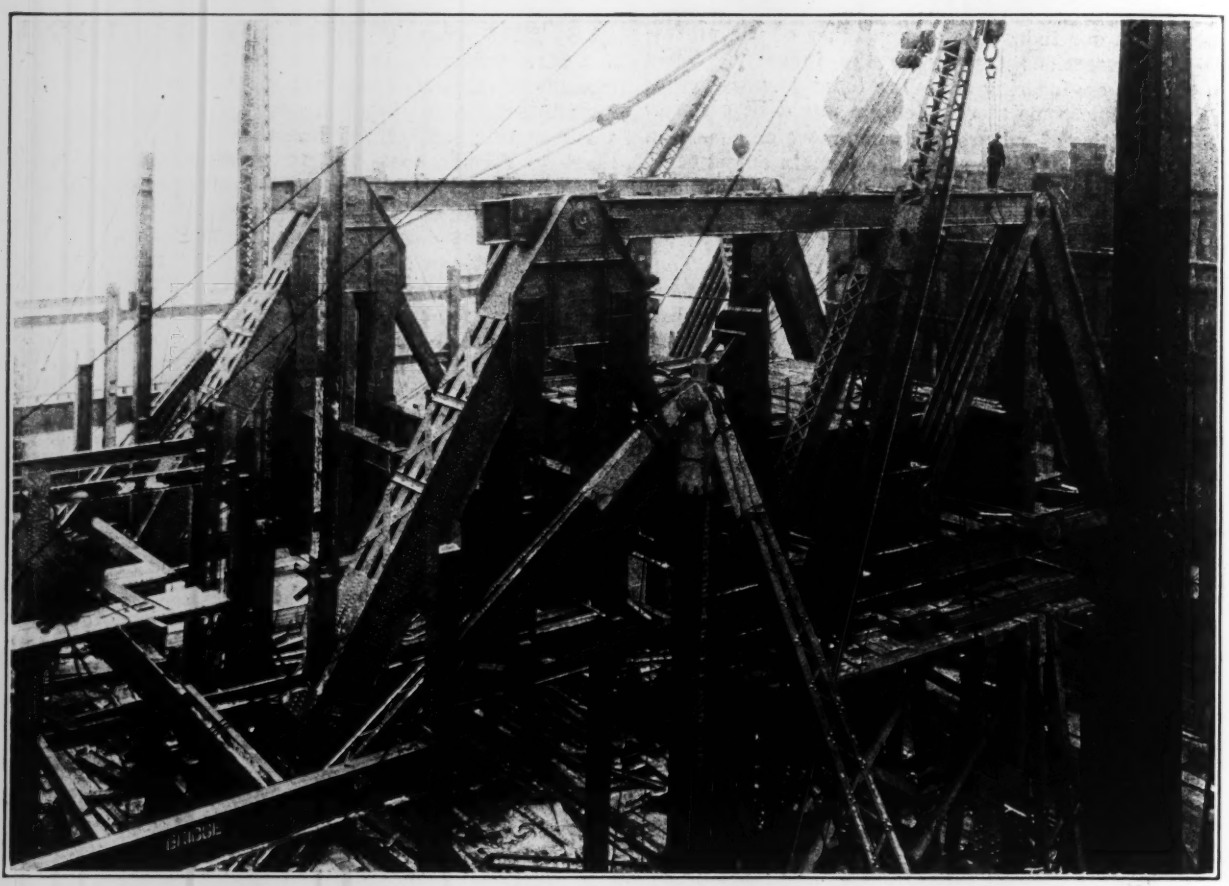


FIG. 1—PIN-CONNECTED THREE-STORY TRUSSES IN STEVENS HOTEL, CHICAGO
North end, showing saddle on end pin carrying hangers for floor girders. Casting projecting beyond top chord will carry columns.

Main Truss Design—An unusual feature in the design of the large trusses is the use of a combination of riveted and pin connections for the members, with extensive use of eyebars, as shown clearly in Fig. 5. There were several reasons for this. To meet architectural requirements the depths of chord sections were limited, and in order to get sufficient metal in these sections to provide for the stresses, it was necessary to use a triple-web section. But with this triple-web section it was not feasible to obtain proper connection for the middle web by riveting. Furthermore, since the trusses are located in court walls, gusset plates of

FIG. 2—PAIR OF 86-FT. TRUSSES ERECTED
Note short eyebars in south end and long eyebars in north end of bottom chord.

adequate size could not be used on account of the windows required in these walls, while pin connections were readily feasible. On the other hand, the bottom chord had to be designed to support floor loads and provision had to be made for connecting the girders supporting the superimposed columns to the vertical truss members, hence certain members were made of riveted sections. Thus a combination of riveted and pin-connected construction resulted.

Columns for Main Trusses—Columns of exceptional weight and dimensions are required to carry the main trusses, the load at the base of the columns being from 3,000 to 4,000 tons. Like the truss members, noted later, these columns, Fig. 6, are of triple-web section, built of plates and angles, with full-length longitudinal diaphragms between the webs, and having lacing on the flanges. The central web consists of a 42x1-in. plate with four flange angles 8x8x1 in. and two side plates 26x1 in. Each outer web has two plates 42x$\frac{7}{8}$ in., a side plate 26x1 in. and two flange angles 8x8x1 in. Diaphragms between the webs are built up of a plate 12x$\frac{1}{2}$ in. and four angles 5x3$\frac{1}{2}$x$\frac{1}{2}$ in.

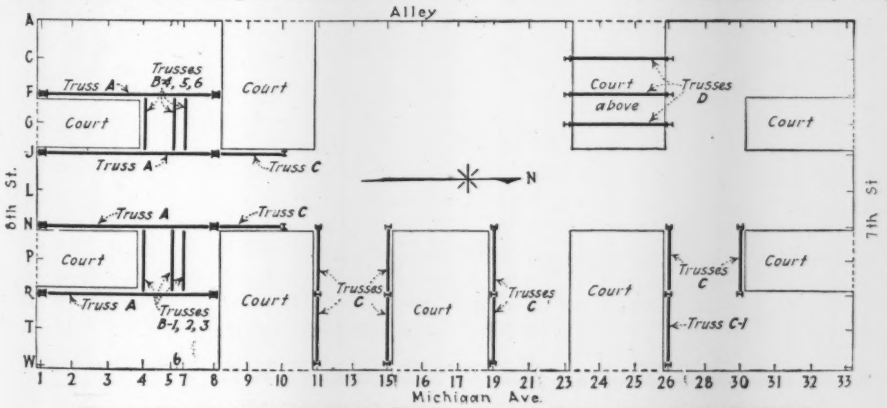


FIG. 3—DIAGRAMMATIC PLAN SHOWING LOCATION OF LARGE TRUSSES IN FLOOR FRAMING, STEVENS HOTEL

These columns were fabricated in one length, 77 ft. 7 in. from base to center of pin, and weighed from 70 to 90 tons each. They were hauled to the site on a truck specially built for this purpose, having two wheels at the front and four wheels at the rear, all rubber tired, the truck being pulled by a tractor. In erection, the columns were handled with two stiff-leg derricks of 45 tons capacity, having booms 100 ft. long. The trusses were also set with these derricks, the heaviest section weighing about 47 tons. Falsework was required in the erection of the trusses.

The foundations for the hotel are concrete piers resting on bedrock approximately 100 ft. below the street level. Those piers which support the columns carrying the heavy trusses are from 7 ft. to 9 ft. in diameter.

Floors and Minor Trusses—Floor framing between the main trusses consists of transverse plate girders between the truss posts, with their tops below the sixth floor level. At three panel points, however, transverse two-story triangular trusses of V-shape are used instead of the girders. These trusses, *B*, shown in Figs. 4 and 7, are 30 ft. 3 in. and 34 ft. 5 in. in span, 17 ft. 10 in. in depth, with the top chord at the seventh floor level and the end posts meeting in an apex at the fifth floor. These trusses were used in place of plate girders for architectural reasons, in order to provide proper openings for access from rooms to corridors and for windows in court walls.

Except for plate girders between the main trusses and at certain other points the floor framing is mainly of I-beams, with concrete slab floors in some panels and concrete joist and slab floors elsewhere, the joists being concealed by suspended ceilings of wire-lath and plaster. Horizontal diagonal bracing in the floors provides for wind stresses and vibration. Above the fifth floor there are light courts between alternate main trusses; the slab panels at fifth floor level form the bottom of these courts.

Trusses of small size are required at several other parts of the building, as indicated in Figs. 3, 4 and 7. Along the Michigan Ave. front there are several trusses, *C*, of about 35-ft. span extending back over two bays in order to provide clear space for the lounge and main dining room. These trusses are of triangular shape, with the bottom chord attached to columns at the fourth floor, and the three posts meeting at the sixth floor to carry an intermediate column. At one point, however, two closely spaced columns have to be carried, and here the truss, C-1, has a top chord long enough to support the columns, so that there is a short panel between two vertical truss posts.

In the rear of the building, as also shown, there are four shallow trusses, *D*, of 50-ft. span and 7-ft. depth, extending over three bays. These are a little above the fourth floor level and carry a roof over a banquet room. Above this roof is a light court, so that the trusses do not support any superstructure loads. These 50-ft. trusses weighed about 4,200 lb. each.

All of the smaller trusses were built complete in the shop.

Details of Main Trusses—Some idea of the massive construction of the 86-ft. trusses may be obtained from the drawings, Fig. 5, and the accompanying particulars. The end posts, 42½ in. deep and 43 in. wide over the flanges, are composed of three built-up webs; the middle web is of I-section and the outer ones of channel section. Transverse diaphragms are placed at intervals and between these are longitudinal diaphragms in the center line of the post. The top chord is of similar section, 34½ in. deep. These three members have on both flanges double or cross lacing of bars 5½x⅝ in., as well as 6-in. channel ties or batten plates at intervals. The bottom chord, 42 in. deep, has two webs of I-section, with cross lacing over the top and bottom flanges. In most of these built-up sections, side or filler plates are riveted against the web plates in the spaces between the legs of the flange angles.

An unsymmetrical arrangement of web members at the north end of the truss is due to architectural conditions, a corridor being in the way of the normal position of the hip vertical. To meet this condition a saddle was made of plates and angles to hang from the end pin, with two vertical hangers from the saddle, giving sufficient width between the hangers to straddle the corridors in the fifth and sixth stories. To these hangers are connected the cross girders supporting the columns located between trusses along the sides of the corridors. The bottoms of these hangers are not connected to the bottom chord, which is made up of eyebars in this panel, but stirrups are formed at the bottom of the hangers to support the long eyebars and thus prevent sag.

Because of cross girders framing to the intermediate posts, these vertical members are made of plate and angle sections with gusset plate connections to the top and bottom chords. The diagonal in the center panel is also a riveted section, since it frames between two riveted verticals. The diagonals in the end panels, however, are composed of eyebars, since the connection had to be made through the pin at the top chord. It will be noted that the lower pins for these diagonals are not placed in the bottom chord, but are above it in

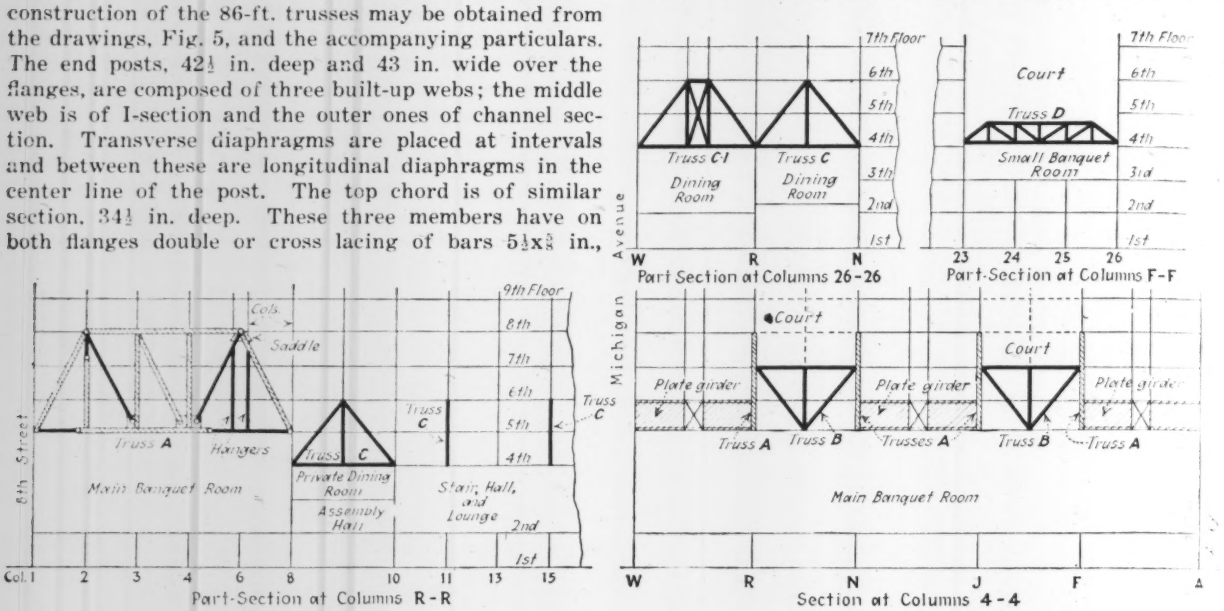


FIG. 4—LOCATION OF LARGE TRUSSES IN STEVENS HOTEL FRAMING AS SHOWN BY VERTICAL SECTIONS

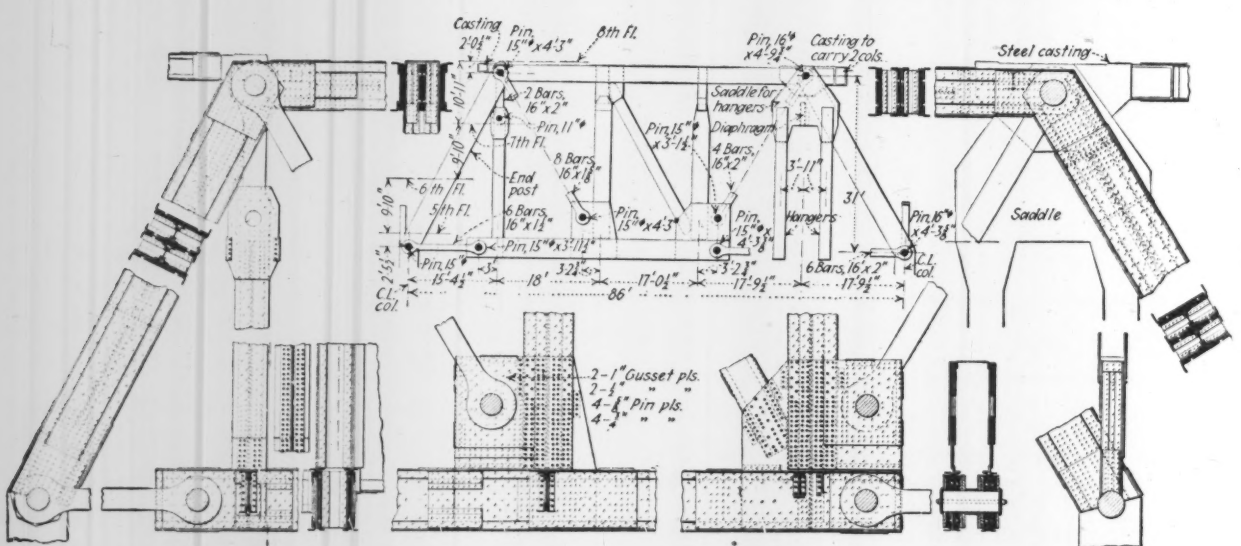


FIG. 5—THREE-STORY 86-FT. TRUSS DESIGNED TO CARRY 22-STORY SUPERSTRUCTURE

the gusset plates which provide the connection between the vertical post and the bottom chord.

For the bottom chord, a double-web section built of plates and angles was used for the center portion

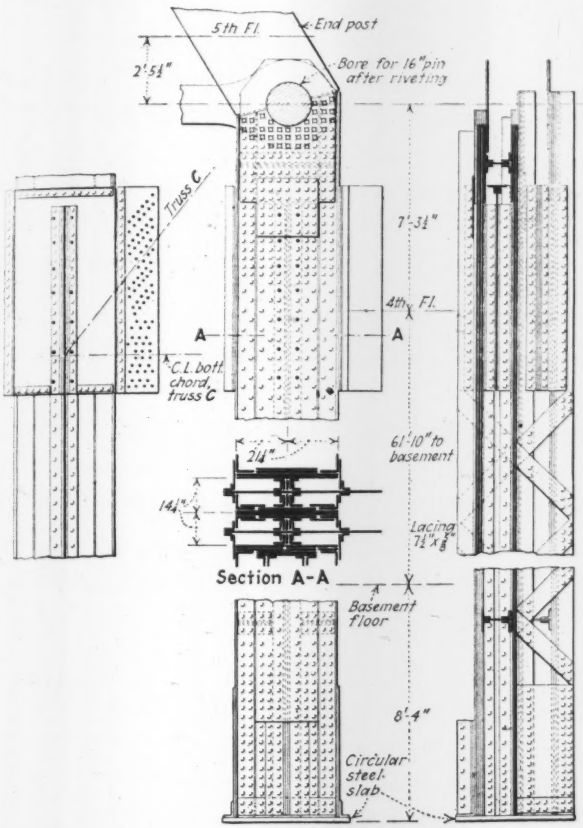


FIG. 6—COLUMN FOR MAIN TRUSS

and extended slightly beyond the panel points of the vertical posts to provide proper bearing for pin connections of the end eyebar sections. At the south end the chord is completed by a group of six eyebars 16x1½ in. in section by 12 ft. 4½ in. long, connected to the pins in the end post and in the stub on the end of the riveted chord section. At the north end the absence of a post at the hip made it necessary to use eyebars 32 ft. 4 in. long, six bars 16x2 in. being used.

At the south end, with a pin at the hip joint, it was impracticable to use a riveted connection for the hip vertical, so two short eyebar hangers were used from the pin at the hip joint to a smaller pin near the top of the hip vertical. The lower end of this hip vertical is riveted to the built-up portion of the bottom chord. The pins in the top chord and end posts are 16 in. in diameter; pins in the lower chord and bottom connection of diagonals are 15 in., while the hanger pin of the hip vertical is 11 in. in diameter.

The truss members are all encased in concrete for fire-proofing. The double- and triple-web members, however, are not filled solid but are cased top, bottom and sides with 4 in. of concrete and are left hollow in the center.

Steel Castings Carry Columns—Still another special feature is to be noted at the north panel point of the top chord of each of the large trusses. Here there were two columns 7 ft. 10 in. apart, one on each side of the corridor in the typical stories above, with the panel point midway between. In order to provide the support for these columns, it was necessary to balance them over the end pin. It was not desirable to support a column on the truss chord, as this would have put a high bending stress in the chord. But with the pin support, the requirements of space for such mechanical equipment as pipes, conduits and ventilating ducts made it impracticable to place between the pin and the column a structural steel member of sufficient depth and strength to carry the column load.

This difficulty in the design was overcome by the use of a large steel casting fitted to the chord pin and of sufficient length to carry the two columns. With this arrangement, the casting is subject to cross bending, with its upper side in tension. Each casting is rigidly connected at one end to a structural steel member, extending to the next building column, designed to counteract any lack of balance of the loads existing on the casting.

After fabrication, inspection of the castings showed flaws in one of them near the pin hole. In view of this and in view of the importance of these castings, it was decided to test each one. Owing to their size and to the amount of load it was necessary to apply, the only testing machine available for the purpose was one at the testing laboratory of the U. S. Bureau of Standards, at Washington, D. C., which has a capacity of 5,000,000 lb. The castings were therefore shipped to Washington and proof-tested on this machine by a load 50 per cent in excess of the design load of 700 tons. None of the castings were tested to destruction. A similar but smaller casting at the south end of the top chord carries a single column over the panel point.

Designers and Builders—The Stevens Hotel will be 400x174 ft. in plan, but with light courts in the typical stories, forming recesses on all four sides, giving the appearance of a group of towers above the fifth floor level. In general the panels are approximately 17x17 ft. or 17x13 ft., with half-panels about 8x17 ft. at cer-

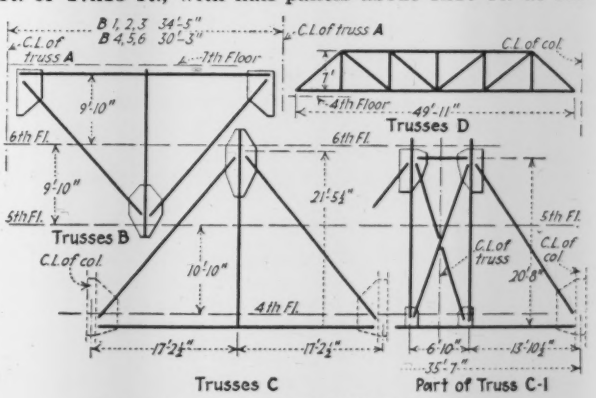


FIG. 7—DIAGRAMS OF MINOR TRUSSES

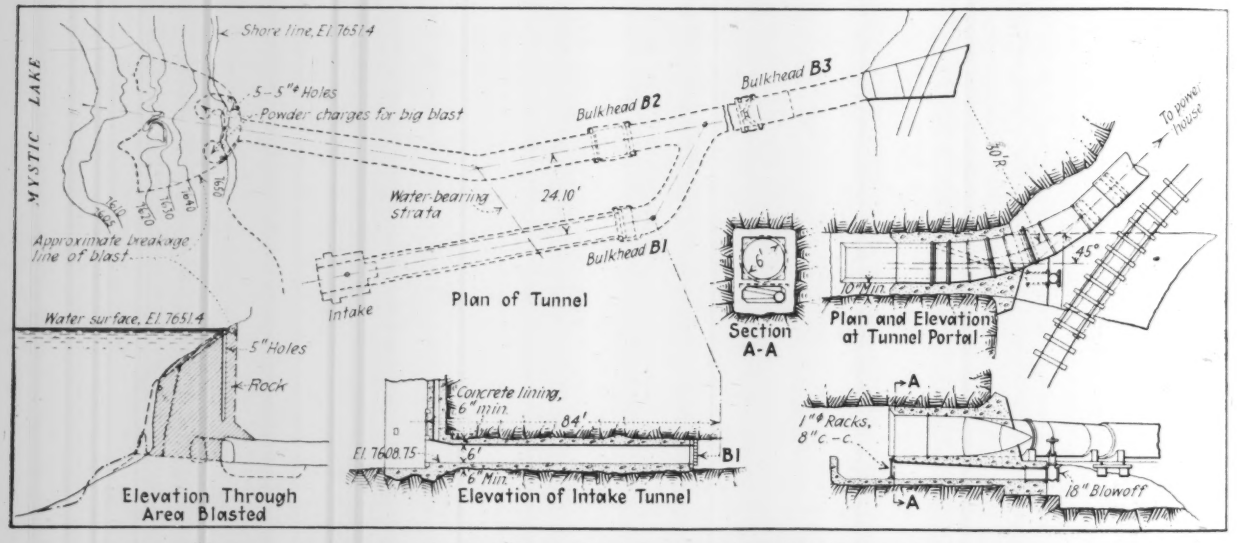
tain points. The live-load is taken as 100 lb. on the lower floors, where crowds assemble, and 50 lb. for the upper floors.

The architects for the work were Holabird & Roche; with F. E. Brown, chief engineer, and Benj. B. Shapiro in charge of the structural design. Henry J. Burt was consulting engineer for the architects. The George A. Fuller Co. is the general contractor.

Tunnel Taps Mystic Lake Below Water Surface

Final Blast Removes Last Rock on Lake End of Bore and Water is then Drawn Down to Permit Construction of Head-Works

IN the construction of the recently completed Mystic Lake hydro-electric project of The Montana Power Co. it was desirable to tap Mystic Lake with a tunnel driven about 43 ft. below low water level. Driving operations were accordingly started at the outlet end of the tunnel and carried toward the lake. A final blast made a large opening at the lake end of the tunnel and although rock fragments partially obstructed the entry of water into the tunnel the scheme as a whole was successful and by this expedient the project was completed in some two months less than the construction



PLAN AND ELEVATIONS OF TUNNEL, INTAKES AND OUTLET

period estimated for the alternative plan of drawing down the lake level by an open cut.

Mystic Lake is a glacial fed body of water on a tributary of the Stillwater River about 45 miles southwest of Columbus, Mont. At El. 5,650 it has a surface area of about 350 acres and an unknown depth, as soundings have not been carried to depths greater than 183 ft. by the company's engineers. The natural outlet of the lake is over a massive dike of quartzite granite through which the tunnel to tap the lake was driven.

Below the tunnel a 56-in. wood-stave pipe line, 9,000 ft. long, conveys the water to a surge chamber at the top of a 2,750-ft. steel penstock. This penstock supplies two 7,500-hp. impulse wheels under an effective head of 1,010 ft. The plant was put in service early in 1925.

Surveys showed the dike at the lake outlet to be of such contour that a tunnel 1,000 ft. long would deliver water to the pipe line at the desired point. It was decided to make the tunnel only 6x7 ft. in cross-section because of the remote location in which the tunnel work had to be carried on, where the delivery and maintenance of mucking machines would have been expensive, and also because of the extreme hardness of the rock. The rock was so hard that 16 lb. of 80 per cent dynamite per cubic yard was required. The work was advanced by two 8-hr. shifts and progress averaged 6 ft. per shift for the first 930 ft.

Here a very wet vertical fault was encountered and some 15 sec.-ft. of water flowed into the tunnel. It was then decided to go back about 65 ft. from the heading and there start another heading striking off at an angle of 40 deg. to the left of the original line. To make sure that this would be feasible a pilot tunnel, 3x7 ft. in section, was first driven on the 40-deg. angle until it was 22 ft. from the main tunnel center line after which it was driven parallel to the main tunnel. This pilot tunnel was carried to within 40 ft. of the lake bed without serious water difficulty and thereupon was enlarged to the 6x7-ft. cross-section.

By this time the water pressure in the fault encountered in the original tunnel had been relieved somewhat and it was found possible to again advance that heading. The face of the original tunnel was then carried to within 11 ft. of the lake bed. During this work a pilot drill hole was kept some 15 or 20 ft. ahead of the working heading at all times, to make sure that there had been no error in locating the lake bed.

The plan decided upon, as the conditions met were analyzed, was to use the original tunnel for drawing down the lake level and then at this abnormally low water level to construct permanent head-works at the intake end of the branch tunnel, after which the tunnel used for unwatering could be blocked up and the reservoir allowed to refill.

In preparation for the final blast 2¾ tons of 90 per cent dynamite was located so that it could be expected to move 700 cu.yd. of rock. In addition to this charge five 6-in. holes were drilled on the lake shore down to a point near the intake end of the tunnel and each of these holes was loaded with 300 lb. of dynamite set to discharge in advance of the main blast in order to throw off as much of the overburden as possible and thus decrease the mass of rock that would have a tendency to drop back into the tunnel opening after the main blast.

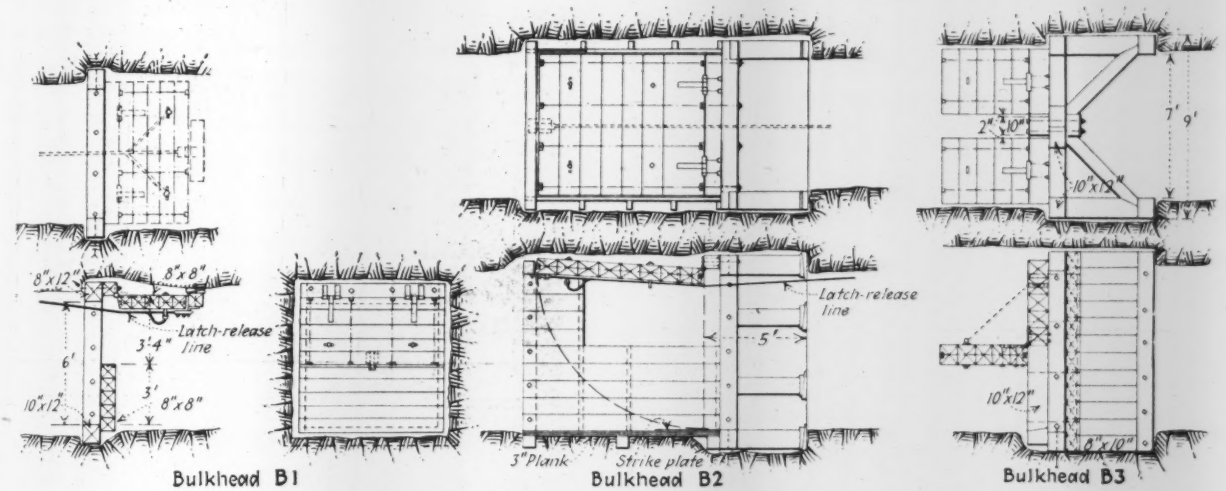
The bulk of the charge in the main blast was placed in two small chambers on either side of the original

tunnel near the intake end. Before placing the main charge about 15 holes were driven radially in a horizontal plane from each of these chambers, and charges in them were timed to go ahead of the main shot.

While the drilling for the main blast was in progress, preparations were made for the installation of bulkheads in the tunnel. One of these, B-2 in the accompanying drawing, was to be located near the junction of the original and the branch tunnels so that when the lake level had been drawn down sufficiently closure could be made here to prevent any further escape of water through the hole made by the blast. A temporary bulkhead, B-1, was built across the branch tunnel near the point where it left the main tunnel, so as to prevent water flowing back into the branch tunnel during the cofferdam was opened and for a short period the water was allowed to flow through the tunnel, thus drawing the lake down again to a level convenient for further work.

All of the concrete used in the head-works had to be placed in freezing weather but a steam heating plant delivered aggregate at about 50 deg. F. as well as hot water for the mix and thus the concreting is reported to have been satisfactorily done even through very severe weather conditions. The concrete in the floors and lower 4 ft. of side walls of intake structure and tunnel lining was placed under water.

The intake gate is of wood suspended from a steel stem, the upper end of which is connected to a worm gear electric hoist controlled from the power house. The distant control is effected by means of a polarized



DETAILS OF BULKHEADS FOR CLOSURES IN TUNNEL

time the lake was being drawn down. Finally a temporary bulkhead, B-3, was also built near the outlet of the main tunnel so that the tunnel could be filled with water to act as backing for the big blast. Labor and materials for the blast and its attendant work totaled about $50,000.

Discharge of the big shot did not effect an opening into the lake as satisfactorily as had been hoped, due to the fact that large rock fragments settled back into the opening and obstructed free flow through it. Nevertheless through the outlet thus provided the lake was drawn down to within 18 ft. of the desired level and this remaining drainage was secured by an open cut made in front of the branch tunnel shaft, this cut being carried down as the water dropped. This shaft was of great advantage in removing the muck from excavation near the headworks instead of having to transport it back through the entire 1,000-ft. length of the tunnel. It is interesting to note that from the evidence observed after the big blast it is believed that the bulkhead at the tunnel outlet failed by being drawn into the tunnel.

Construction on the tunnel was timed so that work on the intake would be under way during the winter months when the inflow into the lake was at a minimum. After the lake had been drawn down to the lowest possible level a cofferdam was built to provide such additional protection from lake water as was needed. During this work, as the level in the lake rose to heights that threatened to interrupt construction, the relay connected to the telephone line between power house and head gate. The relay is actuated by impressing 120 volts direct current on the telephone line and is of sufficient inductance so that the operation of the telephones is not seriously interfered with. The trash racks are sheeted over to a level below the surface of the lake and the gate chamber thus inclosed together with the motor house is electrically heated during the winter months.

The construction of the tunnel was done by company forces under the direction of M. E. Buck, general superintendent, Montana Power Co., to whom we are indebted for the foregoing information.

Many N. J. School Water Supplies Unsafe

Of 740 school water supplies recently examined chemically and bacterially by the Bureau of Chemistry of the New Jersey State Department of Health (John E. Bacon, chief), 389 or 53 per cent were shown to be unsafe, according to the March issue of *Public Health News*, the official publication of the department. By sources, the percentages of unsafe supplies were: Dug wells, 84; springs, 69; cisterns, 40; driven wells, 26; unclassified, 49 (104 supplies examined, 51 unsafe). About 20 per cent of the supplies examined were obtained from outside the school grounds—residences or springs. Dr. H. B. Costill, director of the department, in answer to a query, informs *Engineering News-Record* that most of the schools were in rural districts where there is no public water supply.

Laboratory Reaction Apparatus Helps Operate Filters

Better Application of Chemicals Gives Economical Balance Between Iron and Alum—Saves $4,500 During the Year

By Charles H. Spalding

Formerly Superintendent of Filtration, Oklahoma City, Okla., Now with International Filter Co., Chicago

THE application of chemicals in municipal water softening is doubtless understood by most operating chemists but only recently has anything definite been published relative to velocity, time and temperature factors in the reaction chamber, while the selection of coagulant and the proper time of application has received even less attention. These points have been important enough to warrant study in connection with the operation of the Oklahoma City filtration plant and some of the data may be of interest elsewhere. It is not pretended that these data will apply directly to other waters but the method and principles should be applicable in a general way.

The apparatus used in the experiments consists of a set of six precipitation jars in a row beneath a counter shaft carrying a paddle for each jar. Each paddle is suspended from a disk resting on a small wheel on the counter shaft. The paddle shaft passes through a wooden plug in the jar which holds it in alignment. A small laboratory motor furnishes the power to rotate the paddles. The speed of any paddle may be altered changing the position of the driven disk and agitation any jar may be started, stopped or changed with disturbing the other jars. This machine has been fou extremely useful for determining the most economi proportion and application of coagulants, and tim velocity and other factors in the chemical reactions.

Lime is used for softening, alum and iron sulphat for coagulation. The lime has been added in suspension, usually about 10 c.c. to the liter treated. Alum and iron have been in solution. The choice of coagulant and the proper time of application are covered in the accompanying charts.

Chart 1 shows the coagulating effect of iron sulphate

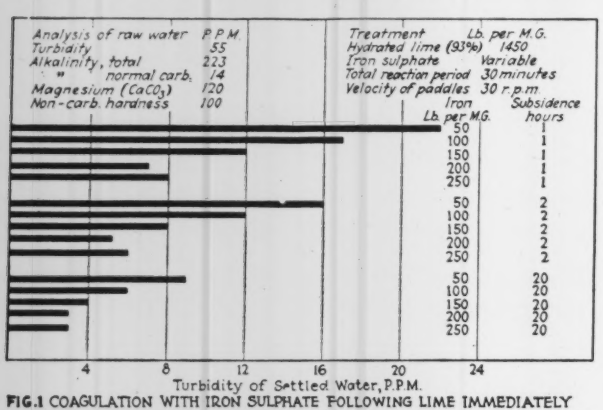


FIG. 1 COAGULATION WITH IRON SULPHATE FOLLOWING LIME IMMEDIATELY

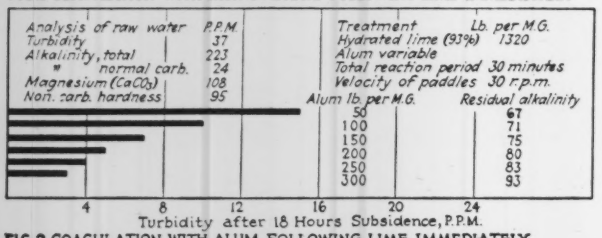


FIG. 2 COAGULATION WITH ALUM FOLLOWING LIME IMMEDIATELY

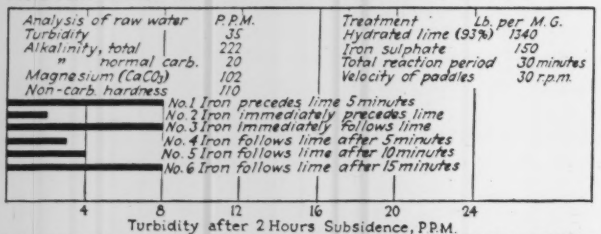

Analysis of raw water P.P.M.
Turbidity 35
Alkalinity, total 222
" normal carb. 20
Magnesium ($CaCO_3$) 102
Non-carb. hardness 110
Treatment Lb. per M.G.
Hydrated lime (93%) 1340
Iron sulphate 150
Total reaction period 30 minutes
Velocity of paddles 30 r.p.m.
No. 1 Iron precedes lime 5 minutes
No. 2 Iron immediately precedes lime
No. 3 Iron immediately follows lime
No. 4 Iron follows lime after 5 minutes
No. 5 Iron follows lime after 10 minutes
No. 6 Iron follows lime after 15 minutes
4 8 12 16 20 24
Turbidity after 2 Hours Subsidence, P.P.M.

FIG. 3 EFFECT ON COAGULATION OF INTERVAL BETWEEN LIME & IRON APPLICATION

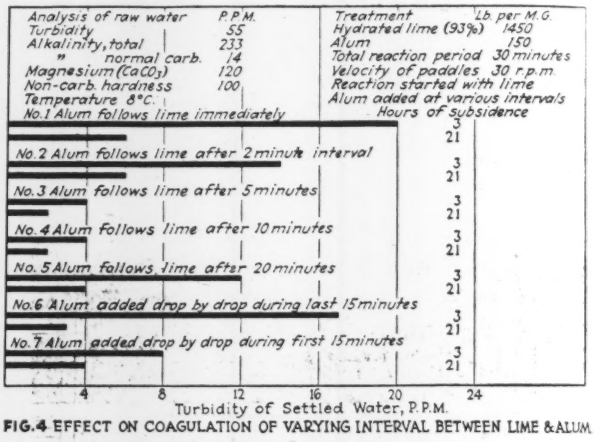

Analysis of raw water P.P.M.
Turbidity 55
Alkalinity, total 233
" normal carb. 14
Magnesium ($CaCO_3$) 120
Non-carb. hardness 100
Temperature 8°C.
Treatment Lb. per M.G.
Hydrated lime (93%) 1450
Alum 150
Total reaction period 30 minutes
Velocity of paddles 30 r.p.m.
Reaction started with lime
Alum added at various intervals
No. 1 Alum follows lime immediately
Hours of subsidence
No. 2 Alum follows lime after 2 minute interval
No. 3 Alum follows lime after 5 minutes
No. 4 Alum follows lime after 10 minutes
No. 5 Alum follows lime after 20 minutes
No. 6 Alum added drop by drop during last 15 minutes
No. 7 Alum added drop by drop during first 15 minutes
3 21
4 8 12 16 20 24
Turbidity of Settled Water, P.P.M.

FIG. 4 EFFECT ON COAGULATION OF VARYING INTERVAL BETWEEN LIME & ALUM

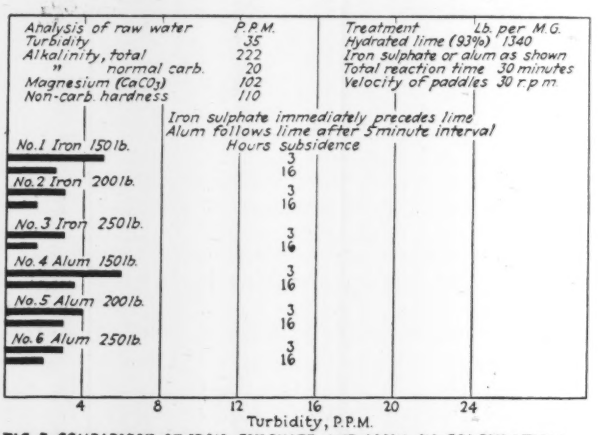

Analysis of raw water P.P.M.
Turbidity 35
Alkalinity, total 222
" normal carb. 20
Magnesium ($CaCO_3$) 102
Non-carb. hardness 110
Treatment Lb. per M.G.
Hydrated lime (93%) 1340
Iron sulphate or alum as shown
Total reaction time 30 minutes
Velocity of paddles 30 r.p.m.
Iron sulphate immediately precedes lime
Alum follows lime after 5 minute interval
Hours subsidence
No. 1 Iron 150 lb. 3 16
No. 2 Iron 200 lb. 3 16
No. 3 Iron 250 lb. 3 16
No. 4 Alum 150 lb. 3 16
No. 5 Alum 200 lb. 3 16
No. 6 Alum 250 lb. 3 16
4 8 12 16 20 24
Turbidity, P.P.M.

FIG. 5 COMPARISON OF IRON SULPHATE AND ALUM IN COAGULATION

FIGS. 1—CHARTS SHOWING APPLICATION OF COAGULANTS AND TIME, VELOCITY AND OTHER RESULTS

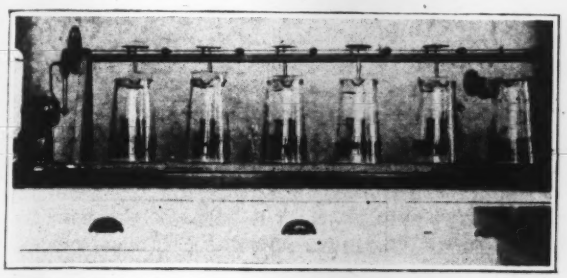
added immediately after lime and the effect of prolonged subsidence. Obviously clarification must wait upon completion of the softening reaction, but in the mixing chamber the two go hand in hand. Clarification is proportional to the quantity of the coagulant. The apparent slight advantage of 200 lb. iron sulphate over 250 lb. is not typical as other tests have demonstrated. The set was selected in spite of this inconsistency because the character of the raw water is about the same as in the other tests described. The residual total alkalinity or carbonate hardness was within 5 p.p.m. of 50 p.p.m. in each treatment shown in chart 1.

Chart 2 shows coagulation with alum following lime immediately, the turbidities of the settled water determined after 18 hours. In chemical and physical

effects alum resembles iron closely. Residual carbonate hardness increases with increasing quantities of alum when applied as in this experiment. The water was slightly undertreated with lime, however. By increasing the lime to 1,425 lb. per m.g. in another set (not shown) 300 lb. of alum left a residual carbonate hardness of 66 p.p.m. as compared with 67 p.p.m. with 50 lb. of alum. It should be remembered that the coagulant increases the non-carbonate hardness about 6 p.p.m. for each 100 lb. per m.g. added, so that the total cost is coagulant plus lime value lost, offering additional incentive to use as little as possible. The main purpose of the first two charts is to show the relative importance of methods of applying chemicals of charts 3 and 4.

It will be seen in chart 3 that iron sulphate added just before lime gives the best coagulation while if iron is to follow lime the softening reaction should proceed for several minutes before the coagulant is added. If the interval is increased beyond 5 minutes, the reaction period for the iron sulphate is correspondingly reduced with subsequent loss in coagulant value.

The next chart shows even greater differences for alum added at different stages. Apparently the interval between alum and lime may be 10 minutes, the remaining 20 minutes being sufficient for the alum reaction. Another point brought out is the advantage of long settling when the conditions of coagulation are unfavorable. When optimum coagulation is obtained long subsidence has little advantage. This may explain varying opinions as to the proper size of settling basins for softening plants. The effect of adding alum ahead of the lime is not shown in this experiment but in another set this order gave a turbidity of 11 p.p.m. as compared to 6 p.p.m. when the alum followed after 5 minutes and the latter method is more economical.



PRECIPITATION JARS UNDER COUNTER SHAFT CARRYING PADDLE FOR EACH JAR

A comparison of iron sulphate with alum follows in chart 5 in which the coagulates are added in the optimum manner indicated by the previous experiments. The advantage is on the side of iron sulphate, especially when the difference in cost is considered.

To evaluate the results of the experiments roughly in the extreme cases the following comparison may be made: 300 lb. of alum added immediately after lime requires 18 hours to produce a turbidity as low as 3 p.p.m. with an increase in non-carbonate hardness of 18 p.p.m. By proper application of iron sulphate, 150 lb., we obtain a turbidity of 2.5 p.p.m. in 16 hours with an increase of only 8 p.p.m. in non-carbonate hardness. Or with 200 lb. of iron sulphate a turbidity of 3 p.p.m. is obtained in 3 hours with an increase of 11 p.p.m. in non-carbonate hardness. The coagulant cost at this plant plus lime value lost would be $6.48 per million gallons in the first case, $2.05 in the second and $2.76 in the third. In the last case the settling basin could have given the same results at one-sixth the capacity.

The foregoing figures are not to be taken at their face value, however, nor do they necessarily apply elsewhere. Plant operation is not duplicated in the laboratory and in actual practice it has been found necessary to use quantities of coagulant which will produce turbidities below 1 p.p.m. in laboratory experiments, but 5 p.p.m. or more in the plant. The range for these experiments was selected to produce turbidities easily measured in 100 c.c. samples. Moreover, the use of alum, 50 to 100 lb. per m.g., has been found advisable, iron alone failing to give as clear a filter effluent apparently on account of a difference in the character of the residual floc going onto the filters.

The practical application of the data shown, therefore, has been the use of both alum and iron sulphate in the manner already indicated, iron sulphate furnishing the major coagulation while alum prepares the water for filtration. To the extent that iron sulphate has been substituted for alum, the saving has been about $4,500 during the last fiscal year. To this should be added increased economy in application of chemicals.

The author desires to state that although the work was carried out independently, C. E. Bretz, superintendent of the Oklahoma City Water Department, made the work possible through his co-operation.

Recovery of Gas From the Decatur Imhoff Tanks

Abstract of Article by William D. Hatfield, superintendent and chemical engineer, Sanitary District, Decatur, Ill., presented at the recent meeting of the Illinois Society of Engineers.

ABOUT one-tenth of the gases given off from the decomposition in the Imhoff tanks of the sewage-works of the Sanitary District of Decatur, Ill., is being collected by a cover placed over the central gas chamber of one of the tanks. The sewage consists of 5 m.g.d. of domestic sewage and from 8 to 12 m.g.d. of waste from the starch plant. The starchworks sewage consists of about 3 m.g.d. of true starch waste and from 5 to 9 m.g.d. of lake water used in condensers. This unexpected volume greatly overtaxes the capacity of a plant designed to settle 8 m.g.d. in Imhoff tanks and oxidize 3.5 m.g.d. on its three acres of sprinkling filters. The domestic sewage on the basis of the biochemical oxygen demand is equivalent to a population of about 40,000, which is the calculated contributary population. In contrast, the total mixed sewage as it is received at the plant has a population equivalent of 350,000 which is over eight times the concentration of domestic sewage.

A very conservative estimate from the present measurements indicates a total volume of gas from all the tanks of from 50,000 to 200,000 cu.ft. per day. The average production is probably about 180,000 cu.ft. per day, with a minimum of about 50,000 immediately after cold winter rains or melting snows. These figures, however, give no clue as to how much greater the summer production will be. The gas as measured is equivalent to one-fifth of the gas furnished the city of Decatur by the gas company.

The analysis of the gas shows that it contains from 70 to 80 per cent methane and from 20 to 30 per cent carbon dioxide and nitrogen. The hydrogen sulphide varies from 0.1 to 1 per cent of the gas, which shows that this gas is a considerable factor in the odor situation.

The calculated calorific value of the gas is about 700 B.t.u. per cu.ft. This is more than 100 B.t.u. higher than the coal gas furnished to the city. The engineers of the Sanitary District have estimated that about 60,000 cu.ft. will be required to burn up the odors about the plant. The remainder could be sold to the city gas company or used to generate power for a proposed pre-aeration plant. About 14 cu.ft. of the gas will generate one brake horsepower per hour in a combustion engine.

Center Joints Reduce Cracking of Seattle Pavements

Experience With Center Groove Has Developed a Design of Part-Depth and Through Joints Which Promises Advantages

By W. H. Tiedeman
Principal Assistant City Engineer, Seattle, Wash.

WHEN concrete paving was begun in Seattle during 1916, the reasons for adopting this new type seemed quite logical. Some surface that would give greater security against skidding had every promise of meeting with the public's favor. As to cost of concrete, the city was especially fortunate with respect to aggregates. The huge glaciers which once covered the Puget Sound region brought down great quantities of sand and gravel and very obligingly dumped them in deep deposits virtually in the city's back yard. Judged by every standard, this sand and gravel is of the highest quality and is procured at a very reasonable cost.

The first specifications borrowed ideas from current practice elsewhere. The standard width of residential streets had been established as 25 ft. and panel lengths of 30 ft. were first adopted for the concrete pavement. These early pavements soon showed numerous transverse cracks and thought naturally turned to means of averting them. On one improvement ten panels, each 20 ft. long, were built, the rest of the job being 30-ft. panels. This roadway was 20 ft. wide. By degrees transverse cracks began to develop in the 30-ft. panels, while the 20-ft. sections remained intact. This seemed to indicate something favorable, so on future residential street paving the 20-ft. panel length was adopted. Instead of getting transverse cracks, as formerly, cracks now formed in a longitudinal direction and, apparently, nothing had been gained by the new plan.

About this time, circumstances compelled the city to pave a 30-ft. roadway in one operation. Feeling that a longitudinal crack would form, it was decided to make a slot at the center line of the street in the finished panels while the concrete was still soft and to insert therein a strip of elastite 2 in. deep. The pavement was first finished from curb to curb as if no slot was to be made. Then the slot was formed, using a chalk line to mark its position, and driving a 2-in. T-iron about 6 ft. long into the concrete with a sledge hammer. No trouble was experienced in getting the expansion joint material down into place. The edges of the joint were finished in the customary manner. This pavement is now nearly six years old and no longitudinal cracks have formed. The intersecting streets were paved later. They are only 25 ft. wide and were put in without longitudinal joints. Their appearance is well shown in the accompanying views. There is every reason to believe that a crack does exist in the concrete directly under the "dummy" joint in the 30-ft. street but since this is a natural crack in the concrete, it undoubtedly does not occur as a vertical plane and the two halves of the pavement are keyed and interconnected and there has been no dropping of one panel below its neighbor, as is sometimes the case where a formed joint is made through the pavement.

During the 1925 season, about 40 miles of paving

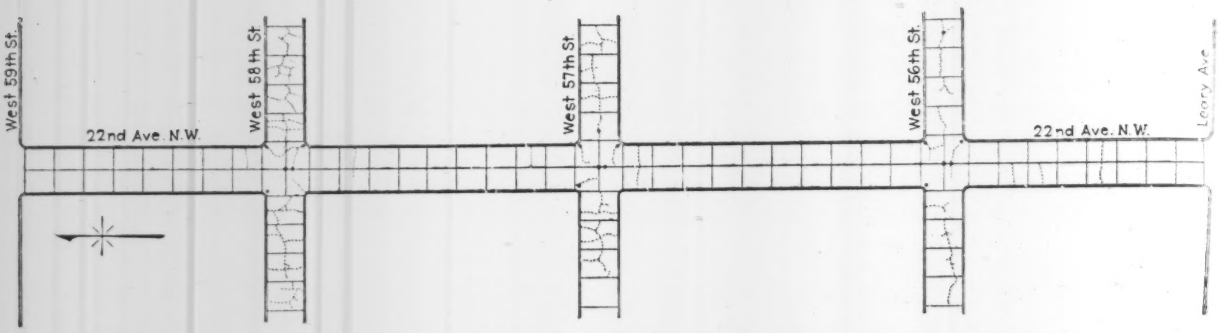
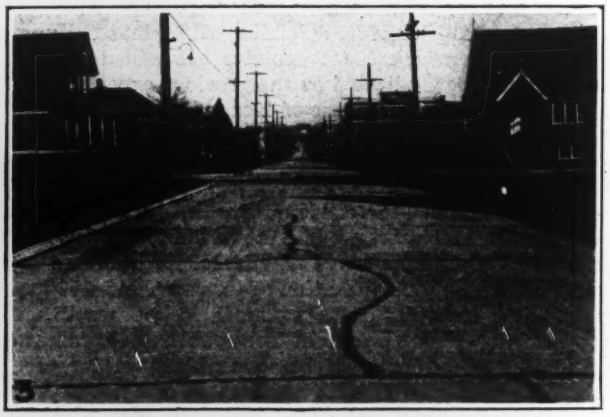


FIG. 1—CRACK CHART OF PAVEMENTS WITH AND WITHOUT LONGITUDINAL JOINTS



FIGS. 2 AND 3—CRACK CONDITIONS ON STREETS CHARTED IN FIG. 1
FIG. 2—Dummy longitudinal joint in 22nd Ave. Fig. 3—W. 58th St. without longitudinal joint

were laid on residence streets with roadway 25 ft. wide, panels 20 ft. long and a 2-in. "dummy" joint along the center line. To date no longitudinal cracking has been observed in these 1925 pavements. In recent years attempt has been made to secure the best possible surface finish and especially careful workmanship at joints. Inspectors are given cast aluminum straight-edges 6 ft. long, notched in the center, and they are required to test carefully the finish of every panel and joint. The results have been very good. However, the original true surface did not always remain so after traffic was turned upon a street because of occasional settlement, generally slight, at the transverse joints. To obviate this, it is planned for 1926 to make the panels as determined by "through" joints 60 ft. long and to use the 2-in. "dummy" joint along the center line and divide the 60-ft. panel by transverse "dummy" joints spaced 15 ft. apart. This will, it is the opinion, remove two out of three places where, under former practice, settlement might upset the fine finish. Furthermore, this will likewise eliminate two of the three places where heretofore it was most difficult to secure placement of concrete. It has been the experience that placement is more difficult beside the full joints than elsewhere in the slab. Inasmuch, as stated above, the "dummy" joint is placed after the pavement has been struck off and finished, two-thirds of this difficulty will also be eliminated. Also this year, on each large improvement it is planned to lay an experimental stretch 600 ft. long with nothing but these 2-in. "dummy" joints, both longitudinal and transverse. If this proves satisfactory the construction will be adopted on future work, making provision for expansion only at points such as sharp breaks in grade where heaving would otherwise be quite certain to occur.

Two Improved Methods of Electric Welding

STUDIES carried on in the Schenectady and the Lynn laboratories of the General Electric Co. by different investigators have developed two new methods of electric welding, which enable greatly improved results to be obtained, characterized by highly ductile weld material. Announcement of the discoveries has just been made by the General Electric Co. A bath of hydrogen or other gas is used in both processes, as a means of excluding air from the region of the weld, this protection preventing the formation of oxides and nitrides in the weld metal. In detail, the two methods are radically different however.

In the Schenectady laboratory, Dr. Irving Langmuir developed a method which involves passing a stream of hydrogen between the two electrodes which carry the welding arc. The heat of the arc breaks up the hydrogen molecules into atoms, and a short distance in front of the arc these atoms recombine into molecules, thereby liberating an enormous amount of heat and producing much higher temperatures than obtained with the usual welding methods. A powerful reducing action is exercised at the same time, which reduces any oxide present and prevents the formation of oxides on the surface of the metal. Alloys containing chromium, aluminum, silicon or manganese can be welded without fluxes.

The discovery had its origin in an observation made 15 years ago by Dr. Langmuir while studying the loss of heat of the tungsten filament of incandescent lamps in a hydrogen atmosphere. He found that in a high temperature the hydrogen gas passes into the atomic state. Recently he found that atomic hydrogen is also formed when a powerful electric arc passes between tungsten electrodes at atmospheric pressure in the hydrogen atmosphere. Directing a jet of hydrogen from a small tube into the arc, he found that the atomic hydrogen could be blown out of the arc, forming an intensely hot flame of atomic hydrogen burning to molecular hydrogen, a short distance beyond the arc. This flame liberates about half again as much heat as does the oxy-hydrogen flame, and is able to easily melt molybdenum, one of the most refractory metals. Quartz melts less easily, though it has a lower melting point, and it is believed that the metal acts as a catalyst in the recombination and therefore helps to produce a higher temperature.

Technical development of the new process was carried out by several men in the Schenectady laboratory, including R. A. Weinman and Robert Palmer. In the preferred type of torch developed, the two electrodes are tungsten rods, held at an acute angle with each other by lava insulators. Normally these are in contact, but can be separated by pressure on the lever mounted on the handle, or slowly adjusted by a screw. Hydrogen is supplied by a tube through the handle. Sufficient gas is used to surround the working area with hydrogen, not merely the electrode tips. The required gas pressure is small. The consumption ranges from 20 to 30 cu.ft. per hour. Alternating current is found more convenient than direct current. Various electrode materials and gas mixtures have been worked with, but in most cases tungsten electrodes and hydrogen gave the best results.

In tests of welds, the welded portions have been twisted and bent double without cracking or otherwise being injured. Ordinary arc welds are too brittle for this treatment.

In the other method of welding, developed by Peter Alexander at the Lynn laboratory, hydrogen is used in its molecular form, and acts both as a flux and as a shield against atmospheric gases. The process originated from the study of the metallurgy of arc deposited metal and the causes that limit its ductility. The metal deposited in this welding process has not only high ductility but also a higher elastic limit than normal metal. The elastic limit of pure iron electrodes before deposition averaged 29,000 lb. per square inch, while the elastic limit of this electrode metal after being deposited by the arc in hydrogen averaged 42,000 lb. per square inch.

In this process the electrode is surrounded by a hydrogen stream which burns along its outer surface in contact with the air. The welding tool comprises a torch or nozzle and a supply unit, in which latter a direct-current generator, a gas hose and a spool of welding wire are mounted as a unit on one base.

At the suggestion of Prof. Elihu Thompson, mixtures of hydrogen and carbon monoxide were tried. Water gas, consisting of about equal volumes of the two gases, enabled specially ductile and easily made welds to be produced. Methanol or synthetic wood alcohol also served well, which is important with respect to portability. Mixtures of nitrogen and hydrogen also were successful in giving ductile welds, and it therefore seems possible to use liquid anhydrous ammonia. The process is now being extended to the welding of alloy steels, non-ferrous materials and their alloys.

Lime-Silica Index as Measure of Cement Quality

Proposal to Grade Portland Cements In Terms of Both Strength and the Relative Content of Cementing Constituents—Specification for Tensile Strength and Quality Proposed

By Thaddeus Merriman
Chief Engineer, New York Board of Water Supply, New York City

IT IS generally agreed by the best authorities[1, 2] that the principal components of portland cement are tricalcium aluminate ($3CaO.Al_2O_3$), tricalcium silicate ($3CaO.SiO_2$) and beta dicalcium silicate ($2CaO.SiO_2$). The minor components are believed to be magnesium oxide (MgO) and tricalcium ferrite ($3CaO.Fe_2O_3$)[3]. In addition, the cement also contains added gypsum ($CaSO_4.2H_2O$), together with small quantities of the alkalis, raw silica, water and carbon dioxide (CO_2).

Of these components, only the tricalcium and dicalcium silicates are believed to be possessed of cementing qualities. The others, except possibly tricalcium aluminate, are therefore to be considered as inert matter. Tricalcium silicate, of itself, displays all of the properties of average portland cement.[2] Its hydrations proceed in an orderly manner and the addition of a retarder to control its reactions is unnecessary. It is the component without which cement would not be portland. Dicalcium silicate, on the other hand, hydrates slowly and develops little, if any, strength until after the lapse of several weeks.[2]

The preceding outline is a condensed statement of the best knowledge regarding the composition and cementing qualities of the components of portland cement. It does not, however, contain an answer to that important question which is being asked on every hand —namely, how is it possible to distinguish between cements on the basis of their content of cementing value?

Coal is sold on its thermal units, asphalt by the bitumen it carries, fertilizer on its percentage of nitrogen, while cement still sells by the barrel. In the world of finance the banker computes his percentages to thousandths, but in the construction world intrinsic cement value receives scant consideration.

By applying the method used for the recasting of chemical analyses of minerals, Colony[3] has shown that the percentages of tricalcium and dicalcium silicate present in a completely burned cement may be computed. By combining an adaptation of this procedure with the showing of cementing content as indicated by the tensile strength a method has been developed by which cements may be classified with respect to their content of absolute quality.

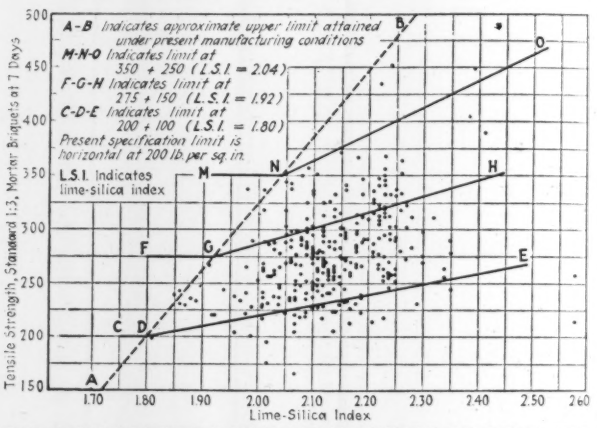
In the accompanying tabulation are shown certain data for eight cements of widely varying characteristics.

What is the Lime-Silica Index—The lime-silica index shown in the tabulation for each cement is the percentage of lime in the cement which is available for combination with the available silica divided by the percentage of the available silica. As already pointed out, only the tri- and dicalcium silicates are possessed of cementing value. Hence, in determining the value of a cement, only the lime and silica available for combination with each other should be considered. All other combinations and substances are practically inert and must be excluded if a clear understanding of the possibilities is to be had.

The available silica is the total silica less the insoluble residue, while the available lime is the total lime less the lime which is in combination with the alumina, the ferric oxide and the sulphuric anhydride. The percentage of lime in combination as tricalcium aluminate is the percentage of alumina multiplied by 1.64. The percentage of lime in combination as tricalcium ferrite is the percentage of ferric oxide multiplied by 1.05, and the percentage of lime combined as calcium sulphate is the percentage of sulphuric anhydride multiplied by 0.70.

By way of example, in cement *A* the available silica is 23.27 — 0.10 = 23.17 per cent. The available lime is 61.65 — (6.08 × 1.64 + 2.34 × 1.05 + 1.57 × 0.70) = 48.12 per cent. The lime silica index, then, is 48.12 ÷ 23.17 = 2.08.

A cement in which all of the lime is combined with the silica in the form of the desirable tricalcium silicate would show a value for the index of 2.80 which is the ratio between the weights of three molecules of lime and one molecule of silica. Since tricalcium silicate is the highest known form of the lime-silica compounds, an index value of 2.80 cannot be exceeded unless free lime be present. Many practical considerations, however, operate to hold the index far below 2.80, which represents the extreme of theoretical perfection.



RELATION BETWEEN LIME-SILICA INDEX OF PORTLAND CEMENT AND 7-DAY TENSILE STRENGTH OF STANDARD MORTAR BRIQUETS

A cement in which all of the lime is combined with the silica as dicalcium silicate would show an index of 1.87 (the ratio between the weights of two molecules of lime and one of silica). This value then represents the lower limit for the lime-silica index in cements which have been calcined only to the point of producing dicalcium silicate.

The foregoing considerations render possible the following deductions:

1. The quantity of the cementing components contained in any particular cement depends on the thoroughness with which its lime-silica combinations have been perfected.
2. A cement of low lime-silica index can never be made so as to contain as much of cementing value as another cement of higher index value which has

been manufactured with equal care and thoroughness.

3. The higher the lime-silica index of a cement and the lower its 7-day strength, the less thoroughly have its combinations been completed.

If the eight cements in the accompanying tabulation had all been ground to the same degree of fineness at the raw end and had been calcined so as to insure equal degrees of combination, then their cementing values, as indicated by their strengths, should have been in proportion to their respective lime-silica indices. The values for the tensile strengths at 7 days, however, show wide variations which, it seems, can be attributed only to differences in the completeness of the formation of the lime-silica compounds which they contained. (The matter of the fineness of the cement will be referred to later on.)

The 7-day tensile strength has been adopted in this discussion because much data are available at that age. It is believed, however, that the strength at 3 days would be an even better criterion because it would be more truly indicative of the tri-calcium silicate content of the cement. As already pointed out, this is the most valuable of all the components and is believed to be the one which produces "the amorphous constituent" that is always present in the greatest proportion in the best and most durable concretes.[4]

LIME-SILICA INDEX AND TENSILE STRENGTH OF CEMENTS OF VARYING COMPOSITION

		A	B	C	H	D	E	F	G
Silica	SiO_2	23.27	22.56	21.17	21.68	21.19	20.85	20.69	24.68
Lime	CaO	61.65	62.73	62.83	61.92	61.60	63.04	65.32	66.82
Alumina	Al_2O_3	6.08	7.52	8.55	5.78	7.13	6.76	7.68	2.11
Iron oxide	Fe_2O_3	2.34	2.27	2.81	3.14	1.77	2.87	1.85	0.92
Magnesium oxide	MgO	3.14	2.02	1.44	2.14	3.98	3.36	0.99	1.73
Sulphuric anhydride	SO_3	1.57	1.72	1.75	2.64	1.78	1.68	1.85	0.74
Loss on ignition		1.80	1.15	1.17	2.40	2.46	1.27	1.44	2.90
Total		99.85	99.97	99.72	99.70	99.91	99.83	99.82	99.90
Insoluble residue		0.10	0.45	0.32	0.40	0.28	0.55	0.27	0.62
Fineness per cent passing No. 200 sieve		78.9	82.4	77.8	95.8	93.7	85.8	86.1	94.6
Lime-silica index		2.08	2.11	2.14	2.22	2.23	2.35	2.42	2.57
Tensile strength standard 1:3 mortar at 7 days		220	165	263	449	452	290	390	258

Examples from Tests—In the accompanying figure are plotted the relations between the lime-silica index and the 7-day tensile strength of portland cement standard mortar briquets of 298 cements tested in the Board of Water Supply laboratory during the years 1921-1925. These cements came from 21 different plants in the United States and from four plants in Europe.

On the diagram has been drawn a line *AB* which represents the approximate upper limit of the relationship between tensile strength and the lime-silica index. The more nearly the plotted position of a cement approximates this line, the more nearly does that cement approach what may be said to be the best of that particular composition which is attainable under present methods of manufacture.

A cement the lime-silica index of which is 2.35, and which shows a strength of only 250 lb. at 7 days, has not been as completely and as thoroughly made as a cement of the same strength which has a lime-silica index of 2.05. The first of these cements carries a far larger proportion of undeveloped and inert lime-silica compounds than does the latter.

On the basis of the data presented and in view of the generally accepted premises as to the constitution of cement, there seems to be no escape from the conclusions which have been indicated. Any other interpretation would contravene the best of all the knowledge that is now available.

The deductions above presented may be emphasized in the following theorems:

(a) That cement which shows the highest strength at 7 days for a given lime-silica index has been most thoroughly made and calcined.

(b) That cement which shows the lowest strength at 7 days for a given lime-silica index has been least thoroughly made and calcined.

(c) As between two cements of equal lime-silica indices, that which shows the higher strength at 7 days will contain the least inert and underburned material.

(d) As between two cements of equal strength at 7 days, that which has the lower lime-silica index will contain the least inert and underburned material.

As an important corollary it is therefore indicated that strength alone is not a criterion of either cement value or cement quality. The well-known belief of many users that certain cements "are better than others" thus finds confirmation in such manner as to admit of definite expression.

Fineness and Strength — The relationship between fineness and strength has been investigated by Bates.[5] On the 10 cements studied by him the effect of grinding from an average fineness of 78.3 to 90.5 was to increase the average tensile strength of 1:3 mortar briquets at 7 days from 269 to 300 lb. per sq.in. In detail, the finer grinding caused 3 of the cements to lose strength, while 3 others showed gains of from 6 to 22 lb. The remaining 4 gained from 55 to 113 lb. per sq.in. The evidence as to the effect of fine grinding on the 7-day mortar test cannot, therefore, be said to be convincing. Fine grinding evidently can confer nothing in the way of additional cementing value, although it may render more available that of which the cement is possessed. The grinding of the inert material of a cement so as to cause more of it to pass through a standard sieve is essentially equivalent to the addition of finely divided clay. On the other hand, the more finely the active material of a cement is ground, the more quickly will its cementing qualities become manifest. In other words, fine grinding cannot compensate for either a deficiency of cement value or for an underburning of the product. For the purpose of this discussion, therefore, the effect of fineness on the relationship between the lime-silica index and the tensile strength at 7 days seems to be a factor of minor importance, within the limits of fineness to which cement is now being generally ground.

Practical Applications—The considerations advanced find practical application in the formulation of require-

ments for the determination of cement quality in terms of tensile strength and the lime-silica index. The present specification calls for a minimum strength of 200 lb. per sq.in. at 7 days. A line drawn horizontally across the diagram at this value shows that practically all of the cements tested exceeded this requirement. The present agitation for a strength of 225 lb. at 7 days proposes to draw a new horizontal line at approximately 10 per cent above the old requirement. Such new limit would rule out only a comparatively small number of the cements included on the diagram and would continue to sanction the low burned, high limed cements which contain only a sufficient proportion of cementing material to enable them to meet the minimum strength requirement. Cements of this character contain correspondingly more inert substance of no cementing value and, inferentially at least, seem to be the more likely to produce non-permanent concrete in exposed situations. These cements, moreover, and particularly if finely ground, require greater attention to moisture conditions during the curing period if their full value is to be realized.

Proposed Specification—A rational specification for both tensile strength and quality can be written by taking due account of the lime-silica index. The user who is in the market to get the most cement value for his money should, in order to be certain of quality, specify the strength he requires in terms of this index. By way of example, if it be desired to secure those cements which contain the smallest proportion of the inert lime-silica compounds, the user will require a tensile strength in pounds per square inch at 7 days of:

$$350 + 250 \times (\text{lime-silica index} - 2.04),$$

it being also provided that the strength shall never be less than 350 lb. This requirement will include all cements lying above the line *MNO*.

If, however, the buyer is satisfied with such cement as lies above the general average of that now in the market, he will specify a 7-day strength of:

$$275 + 150 \times (\text{lime-silica index} - 1.92),$$

with the proviso that the strength shall always exceed 275 lb. This requirement would include all cements above the line *FGH*.

As a specification which would be only a small step in advance of present standard requirements the consumer would prescribe a tensile strength of:

$$200 + 100 \times (\text{lime-silica index} - 1.80),$$

providing further that the strength shall never be less than 200 pounds.

It is believed that the considerations which have been set forth will be of interest to those who seek the best of cement value for use in situations where the requirements are such as to demand a product of better than either standard or average quality.

While this discussion has been confined to the important relationship between the lime-silica index and the tensile strength at 7 days, it is to be noted that the quality of a cement is also dependent on its content of alumina, of magnesia, of ferric oxide and of calcium sulphate. That is to say, as between two cements of equal 7-day strength and equal lime-silica index, the one which contains the least of the materials enumerated will be the better. The alkalis also have their effect.

All of the information on which this discussion has been based was assembled and co-ordinated by L. Bernard Stebbins, assistant to the chief engineer. The chemical analyses reported were made by Richard G. Gaines, chemist.

[1]The Ternary System $CaO.Al_2O_3.SiO_2$. Rankin and Wright. *Am. Journ. Science* 39, Jan., 1915.
[2]Properties of the Calcium Silicates and Calcium Aluminates Occurring in Normal Portland Cement. Bates and Klein. Technologic Paper No. 78, U. S. Bureau of Standards.
[3]Judging the Quality of Portland Cement. Colony. *Transactions* Am. Inst. Mining & Metallurgical Engineers, 1921.
[4]Petrographic Study of Portland Cement. Colony. Columbia School of Mines *Quarterly*, 36, Nov., 1914.
[5]Effect of Fine Grinding and a Higher SO_3 Content Upon the Physical Properties of Portland Cement. Bates. *Proceedings* A.S.T.M., 15, 1915 and 23, 1923.

Grouting Marston Lake Earth Dike to Stop Seepage

A YEAR ago in January after a snowstorm, the engineers of the Denver, Colo., municipal waterworks discovered a slight crevice one-third up from the outer toe in the 35-ft. earth embankment impounding water in Marston Lake. Later another crevice developed about midway between the toe and the first crevice. Grout-filled auger holes 2 ft. apart in the upstream face above water level have stopped both movement and slight leakage.

Newspaper headlines in March of this year broadcast the information in such a manner as to indicate the dike was failing and the trouble recent. Burton Lowther, chief engineer, writes that most of the trouble was from a newspaper getting panicky and writing scare heads. Further, he states that "there is nothing the matter with the Marston Dike except what is common to a large majority of high earth embankments impounding water." What was done immediately, the observations made and the results, he gives as follows:

Points for observation were set immediately for determining the amount of slip or settlement occurring. After a few observations it was decided to do some exploratory work. Six-inch auger holes were sunk in the outer slope of the embankment, and also just above the water line on the inner slope, sinking these holes in the original foundation on which the bank was placed. The embankment was found to be exceedingly impervious, compact, and composed of a heavy impervious clay. In fact, it was one of the best earth embankments I ever examined. We immediately started out to sink these 6-in. borings down to the original embankment foundation and fill the holes, close together, with grout by means of a 4-in. galvanized-steel pipe.

After making about 50 lin. ft. of such repair we found that the ground water in the test holes of the outer bank was dropping quite rapidly and the seepage which was originally a comparatively small amount had almost entirely ceased. This method seemed to be shutting off the seepage water between the earth embankment and its foundation, which is undoubtedly where the trouble lies.

At present writing the movement, if any, is imperceptible as determined by the most accurate means at our disposal.

We are also draining the old swamp adjacent to the bank. We are cutting heavy ditches about 20 ft. deep in the deepest place and about 15 ft. wide at the top, staying away from the toe of the slope at the greatest distance about 60 ft. The soil in the swamp is composed of about 2 ft. of humus and the remainder of a dry compact soil exceedingly hard and requiring considerable effort on the part of our large excavator to move. Later we will probably put in some subsurface drains and drain the water from the toe of the bank into these main drains. This will probably stabilize the toe of the embankment and entirely cure the trouble. We have been looking for this sort of trouble for years along this portion of the dike because we knew there was some seepage which probably came from the embankment. It is probably a matter which has gone on for years and the amount of settlement is very slight indeed as compared with what might be expected.

At this time there is stored in Marston Lake about 4,400 m.g. of water. The lake is being filled at the rate of 60 m.g.d. and no trouble is anticipated in filling to 6,000 m.g.

Kansas City Meeting of Civil Engineers

Effect of Motor Vehicles on Railway, Urban and Interurban Transportation Main Subject for Discussion—Heavy Registration Encouraging

AFTER rolling up a registration in excess of 400 and holding a good attendance even at the three simultaneous divisional meetings, the officials of the American Society of Civil Engineers last week at the Kansas City meeting felt more encouraged than for some time, over the idea of holding quarterly technical sessions. Highway transport and what it is doing to the railroads, the street railways and the interurban lines in all phases, physical, financial and from the public standpoint was the principal topic presented. It was discussed mainly by those who had been posted, but the majority of those in audiences were either too awe-struck by the authorities who spoke or, as was quite evident in cloakroom conversation, professed that the subjects were out of their field and that the meeting was largely educational rather than discussional. In fact, the elementary treatment of the subjects, with a minimum of the engineering way of presentation through conclusions from cold-fact observation and a maximum of personal opinion, was calculated to produce a rather thin survey of the field. As expected in a civil engineers' meeting, the railroad men were in preponderance and the presentation was largely from the school that believes in giving the public the transportation service it desires both on and off their own right-of-way by entering into the motor coach and truck field. Few, if any, championed the cause of the other school which holds that the railroads should have nothing to do in the way of rendering service off their own property.

A pleasantly diverting address, interlarded with a few well-known engineering facts or alleged facts, characterized a dinner talk on the St. Lawrence Seaway, by Ex-Governor Henry J. Allen. Everybody but New York and Montreal, he claimed, is for the proposal but the governor frankly stated he did not blame these two cities though he felt that they do not realize that what is good for the Middle West will be as good or better for the seaboard in time.

Opportunity for exchange of viewpoint and enjoyment of converse with new-made and old friends was well provided for. Excursions to the filtration plant of the water-works now under construction, to the steel-works, and through the rough and rugged topography of the city so well parked and boulevarded were excellently provided for by the local section and the Kansas City Engineers' Club. A breakfast for the two-score members of student chapters with the officials of the parent society was an innovation which the young men appreciated. No business affairs of the society came before the meeting.

Highway Transport and the Railways—Under the title of "The Relation of Highway Transportation to the Railway," Ralph Budd, president of the Great Northern Railway Co., reviewed the history of the rise of the motor industry and its inroads into the railroad field. Since, he said, we are supporting two transportation plants, the railroad and the improved highways with the motor vehicles, each representing a 25-billion dollar investment, it is essential to utilize and coordinate them as effectively as possible. He summarized the situation as follows:

The superiority of the railway for long distance and bulk freight and passenger traffic is well established; motor truck and bus competition is not a factor in those fields. commercial users of highways should be subjected to reasonable regulation and taxation. Existing and proposed state and federal legislation, generally speaking, will provide for this. The extensive ownership of automobiles and the large mileage of improved highways have resulted in the loss of most of the local passenger travel of the railways, except in the vicinity of the largest cities. The removal of local trains has left many communities with comparatively little railway passenger service. The small amount of local travel in many such instances does not warrant more railway service, but does warrant the operation of buses at comparatively frequent intervals. The station to station and even shorter travel which would not go by rail makes up a considerable portion of the bus traffic. The bus business promises to increase if better service can be given and if the cost of operation can be reduced. The additional business which buses may expect will come largely from automobile users rather than from rail patrons.

Buses may serve to supplement railway transportation more effectively in some localities, if managed by railways, than if operated independently. Street railway and interurban electric lines are making extensive use of buses. The field of the private carrier motor truck is wide, taking the place, as it does, of the horse-drawn vehicle both in the city and in the country. The common carrier truck has a much narrower field, because of the competition with the private truck on the one hand, and the common carrier railway on the other hand, the latter unquestionably being more economical for any but comparatively small lots and comparatively short haul. Motor trucks relieve railway terminal congestion by moving freight direct from door of consignor to door of consignees. In many cases, this does not represent a loss to the railway because at large centers, where trucks are most used, the terminal costs may absorb the profit of rail haul on local freight.

In considering public convenience and necessity—the *sine qua non* for any permit to operate a commercial vehicle on public streets or highways—due regard should be had for the existing modes and means of transport. When essential carriers are able to give service that is measurably similar to that proposed, or when the success or efficiency of the existing essential carrier would be seriously impaired without definite and distinct improvement in service to the public, then public necessity does not warrant the new facility, and it is in the true public interest to deny the application. The public must support whatever transportation agencies are maintained and should not undertake two where one will suffice. On the other hand, where such additional facility is in the public interest and, therefore, is permitted, it should not be hampered by undue restriction or unfair taxation, but should be encouraged to operate as efficiently and cheaply as possible. Under the accepted scheme of providing public transportation in this country, the service is rendered at cost; including in cost, however, a fair return upon the value of the property used for transportation purposes. So long as this principle obtains—and for practical purposes that is so long as transportation is furnished by private rather than by government agencies—it is in the true public interest to avoid unnecessary duplication of capital, and in every other reasonable way to help both old and new carriers keep down the cost of producing transportation. Cheap transportation of the highest quality is the key to much of our past and possibly more of our future prosperity.

Fields of the bus and truck are feeders, branch line service and store-door delivery and pick-up, in the

opinion of J. V. Hanna, chief engineer, Kansas City Terminal Ry., who advocated railroad control through a single responsible agency.

E. A. Hadley, chief engineer, Missouri Pacific R.R., deplored the lack of federal aid for grade-crossing elimination and advocated passage of the uniform tax bill for motor vehicles sponsored by the American Electric Railway Association, American Railway Association and others.

Charles F. Loweth, chief engineer, Chicago, Milwaukee & St. Paul Ry., was of the opinion that many city planners did not take into account in their plans the enormous cost of moving railroads and felt that in many cases the railroads should be the stable portion of the city plan.

F. G. Jonah, chief engineer, St. Louis & San Francisco Ry., indicated the tendency of roads to move freight terminals from high value districts to the low-cost outskirts and that the truck had made this feasible. He noted the move of the Chicago & Alton to inaugurate a motor bus and transport service on the paralleling hard roads adjoining their tracks to give a more flexible service. The old 4- to 7-mile spacing of stations need no longer be observed and the railroads can curtail their short-haul service, in his opinion.

Arthur H. Blanchard, professor of highway engineering and highway transport, University of Michigan, presented the only discordant note in the meeting, disagreeing with many of the railroad engineers and referring pointedly to railroad lobbies to restrict and hamper bus and truck operation. The railroads would not suffer nearly so much as they claim, he stated, if they used efficiently their own equipment which they are able to handle. He advocated trucks for store-door deliveries, short-haul intercity express lines, branch lines, of which no more should be built, and reconstruction of unprofitable roadbeds for private truck and bus operation. One railroad in the West, he said, is now utilizing its right-of-way for a high speed toll traffic way.

Britton I. Budd, president, Chicago, North Shore & Milwaukee R.R. Co. and several other rapid transit lines out of Chicago, presented a paper on "Urban and Interurban Buses" which was read by Charles E. Thompson, his vice-president. The paper is a detailed exposition of how Mr. Budd's properties are co-ordinating motor-coach service with that of the existing facilities. He drew the following conclusions:

In city service the motor coach has its greatest economic value when operated in conjunction with electric railways. It is a most convenient agent to give transportation service along boulevards and parks and to serve as a feeder to electric lines in territory not otherwise served.

In the suburban and interurban fields the motor coach is most useful for comparatively short hauls of 20 miles or under. In long-haul traffic it is not as useful nor as economical an agent as the high-speed electric railroad and should not be operated in territory served by rail. As an auxiliary to the railroad the motor coach has its greatest usefulness in the interurban field, as it can be used to serve territory contiguous to the railroad for a distance of 25 miles or more. The cost of operating motor coach service is greater than the cost of supplying rail service and that is always likely to be so. Railway operators with their special training and experience are the men best qualified to operate motor coaches and co-ordinate them with the railways. In the near future, under a properly co-ordinated transportation system, the motor coach business will simmer down to a sound economic basis. Where it will be found economical to operate motor coaches they will be run and where it is found that the public will be better and more economically served by rail lines, the latter will carry the traffic.

In discussion Robert P. Woods described the experience of the Kansas City, Clay County & St. Joseph interurban of which he is vice-president and general manager, in fighting the bus. People are coming back to the interurbans is the conclusion.

Fred G. Buffe, manager, Kansas City Railways, spoke of the wrecking of street railways by unregulated jitneys. If the public wants *de luxe* service, however, and will pay for it, it is up to the transportation agencies to furnish it, in his opinion.

B. H. Piepmeier, chief engineer, Missouri State Highway Department, outlined the problems of the engineer in providing a roadbed for loads which he could not predict or control. The bus is here to stay, in his opinion, but will be regulated and will give an economical service.

C. E. Smith, consulting engineer, St. Louis, outlined fields of the bus, as at end of rails, in thinly populated areas, cross-town service, feeders for high-speed street car service which runs in the center of a reservation on wide streets.

Prof. Blanchard was equally at variance with the street-car men as with the railroad men. He does not believe the street railway men are equipped to handle buses because he feels it is impractical to do so with union labor, and a better *esprit de corps* must be built up than the street railways generally have been able to effect. As to *de luxe* service, he noted the $1 charge for such service from upper Manhattan Island to Wall St. now contemplated.

Sanitary Division—The whole problem of the Sanitary District of Chicago was briefly reviewed by Langdon Pearse, sanitary engineer for the district, before starting a lantern-slide talk on the design and general features of the $27,000,000 North Side sewage treatment plant which will care for 800,000 people and is 60 per cent completed. Assisting in the preparation of the detailed paper were L. C. Whittemore and I. P. Kane, assistants. On the mechanical and electrical features of the same plant J. T. Hawley, electrical engineer, and H. I. Steffa, mechanical engineer, had prepared a paper. This was read by Mr. Kane. L. B. Barker, senior assistant engineer, spoke with slides on the construction features. This complete series of papers making 100 pp. of material will be recommended for publication by the sanitary division officials. Much of the material is noted in *Engineering News-Record*, March 4, p. 363 and March 11, p. 394.

In discussion, T. Chalkley Hatton, chief engineer, Milwaukee Sewerage Commission, stressed the magnitude of the Chicago program which is to care for 1,121 m.g.d. of sewage and cost $130,000,000. The use of the spiral method of diffusion is the principal advance over the Milwaukee plant. In the North Side 175-m.g.d. plant there are only 58,000 air-diffusion plates while the 85-m.g.d. plant of Milwaukee required 72,000 with a cost nearly double. The second departure is in the 30-min. preliminary settling tanks instead of fine screens. The 1-in. bar screens at Milwaukee remove a minimum of 1.54 cu.ft. of screenings per m.g., a maximum of 6.9 cu.ft. and an average of 4.0 cu.ft. of 64 per cent moisture. The fine screens take out 8.8 cu.ft. per m.g. having a 91.1 per cent moisture which it is planned

to reduce to 55 per cent and then burn, as it contains 8,600 B.t.u. Costs at Milwaukee for air under 10-lb. pressure up to March 26 are for the air $2.77 per m.g. using 1 cu. ft. of air per sq.ft., $3.47 using 1¼ cu.ft. and $4.16 using 1½ cu. ft. Labor and maintenance bring the above figures to $5.43, $6.13 and $6.82 respectively, while the total, including interest, depreciation and amortization of the bonds, brings the corresponding figures to $8.56, $9.26 and $9.95 per m.g. treated.

George W. Fuller, consulting engineer, recently returned from a 7 weeks' inspection of European sewage plants, noted the different trends there in activated sludge plant from practice here. Their pre-treatment is largely settling up to 8 hours with a corresponding reduction of 15 per cent air. Europe uses the spiral flow more generally to save 25 per cent in air, to reduce short circuiting by 20 per cent and to get better aeration thereby obviating reconditioning of sludge. Digestion of sludge with Imhoff or two-story tanks is practiced in Zurich, Munich and Stuttgart. Gas as a by-product is being sold commercially. Birmingham operates a 32-hp. engine and is installing one of 150 hp.

A. W. Fales, of Metcalf & Eddy's office, called attention to the fact that activated sludge digests rather poorly alone, but well with Imhoff sludge. He noted the movement in Chicago to meter the water which will make the 6-hour activated period liberal and prolong the day when extensions will be required.

City Plan Division—Louis R. Ash, consulting engineer, Kansas City, in his paper on city planning, reviewed the whole field thoroughly.

Charles E. Donnelly, engineer of the Kansas City Plan Commission, spoke on ways to reduce the cost of the highway plan. His idea is one gaining ground elsewhere and that is to utilize existing streets by better paving before widening which is expensive and attracts an undue amount of traffic.

Construction Division—E. J. Mehren, vice-president, McGraw-Hill Publishing Co., Inc., spoke on "Scope, Aims and Purposes of the Construction Division." John P. H. Perry, vice-president, Turner Construction Co., New York City, gave a 30-min. running fire comment on "Florida from a Construction Engineer's Viewpoint."

Tests on Cement-Lime Mortars

Tests made by H. B. Johnson, of the United States Bureau of Standards, as reported in Technological Paper 308 of the Bureau of Standards, notes certain of the properties of cement-lime mortars. It was found that the addition of lime to cement mortars increased the water requirements of the same consistency very nearly in proportion to the percentage of lime added. The shrinkage is increased by the addition of extra water. Therefore, where low shrinkage is of prime importance, lime should be limited. The addition of lime cannot be expected to increase the strength of cement mortar richer than 1:2 by weight. With leaner cement mortars, the maximum increase in strength which may result from the proper addition of lime is greater the leaner the mortar. The addition of lime in small amounts increases the density of lean cement mortars. The principal advantages resulting from the use of lime in cement mortars are an increase in workability and a reduction in cost. While a cement gaged lime plaster retains much of the workability of straight lime plaster, the presence of the cement gives it greater strength and a shorter time of set.

Joint Committee on Highway Location at Los Angeles Unifies Many Interests

RECOGNIZING the need for co-ordinated action in working out some comprehensive plan for developing major highways in the vicinity of Los Angeles harbor, there was formed last October a "Committee on Highway Approaches to the Los Angeles Harbor District" whose purpose is to bring together and get co-operative action from the large number of interests involved.

The committee consists of 28 or 30 members, including representatives from all communities, civil organizations, corporations, federal departments and other interests concerned in any way with the development of roads in the harbor district. The primary aim has been to work out a comprehensive system of major highways on the location of which all interests involved can be brought into agreement. With such a plan worked up in advance, as the need for extending the present facilities arises there is a greatly improved prospect of ultimately securing a highway system in keeping with the best interests of the port as a whole. That is, with a carefully laid scheme of development of this sort, real estate subdivision or other selfish interests are less liable to interfere with the common good because pressure is brought to bear from all sides to require conformity to the committee's general scheme.

The committee's method of operation is to put in the hands of a subcommittee of twelve the detail of location. The subcommittee meets once a week, alternately in the field and in the office, and goes over each proposed location in sufficient detail to bring out all factors bearing on the preferable location, all things considered. The subcommittee refers all recommendations for final approval to the committee as a whole, which meets twice a month. Thus far it has been possible to thrash out all differences to a unanimous agreement and a spirit of willingness to give and take has prevailed.

The harbor district as a whole is divided into twelve sections and each section is mapped on a scale of 600 ft. per inch. All major highways in these sections are being planned for a minimum width of 100 ft. (with 74 ft. between curbs) plus additional widths at intersections to permit the separation of grades between major highways if and when this becomes necessary. Rapid transit, railroads and terminal facilities are taken into account. The area in which roads are being actually located and plotted on the map is about 20 miles square, but in connection with these highways the existing and projected systems of roads in the adjacent territory are taken into consideration.

As the sectional maps are completed, they are approved by signatures of the Committee and then endorsed by official resolution by each of the organizations represented.

New Bedford Accounts for 90 P. C. of Water

With an allowance of 3 per cent for slip of meters, all but 10 per cent of the water supplied in 1925 by the water-works of New Bedford, Mass., was accounted for. The amount supplied per inhabitant was 65 gal. The 58 gal. accounted for was divided equally between metered water for manufacturing use and metered water for all other purposes. In 1924, water accounted for was 84 per cent of the total. Stephen E. Taylor is superintendent of water-works.

Concrete Cribbing for Railway Retaining Walls

Four Types—Open and Solid-Face Walls—Beams Interlocked or Pinned—Comparison With Monolithic Walls

INCREASING use by several railways of retaining walls of concrete cribbing, built up of precast concrete members, indicates some substantial advantages over monolithic concrete walls of either gravity or reinforced types. Low first cost, simplicity of foundation work, rapidity and convenience of construction, facility for removal or alteration where eventual reconstruction is foreseen, and high salvage value in case of removal, are among the advantages noted by different railroads. In four designs now in use, two form an open face or wall, while the other two form a closed or solid wall. Three of them are built of inter-

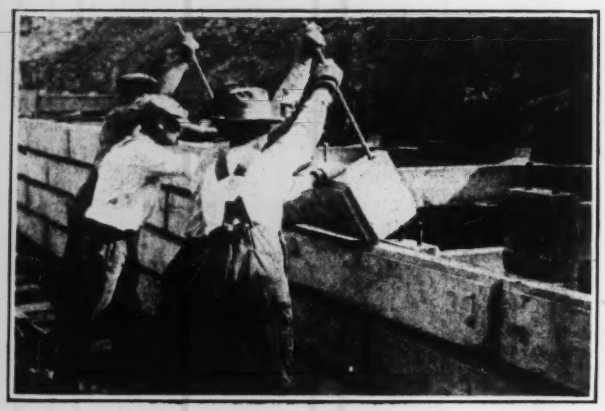


FIG. 1—SOLID FACE CRIB WALL; GRAND TRUNK RY.

locking members, while in the fourth the members are pinned together with loose iron rods or drift bolts set in cored holes and then grouted.

Solid-Face Wall; Grand Trunk Ry.—A new type of concrete cribbing which has the special feature of giving a solid face or wall, instead of the usual open crib-work construction, has been used on the extensive track depression of the Grand Trunk Ry. along its DeQuindre Line at Detroit, Mich. On this work (*Engineering News-Record*, July 10, 1924, p. 60), a four-track roadbed is spanned by numerous street bridges. In the spaces between the bridges, concrete crib walls about 6 ft. high, built in line with the faces of the abutments, retain turfed slopes extending to the right-of-way lines at the street surface. The slope begins a little back from the face of the wall and is rounded off from the top of the wall; this arrangement is designed to hold the sodded slope from slipping, due to the soft clay soil. The cribbing is filled with cinders and sand. One of these walls under construction is shown in Fig. 1, while Fig. 2 shows the details of the members.

Stretchers 6 ft. long, forming the entire face of the wall, are of channel shape in plan, with holes in the end lugs or flanges to engage steel dowels embedded in the ends of header members or anchors of Y-shape which are embedded in the fill. With this construction, the headers do not extend through the wall to its face, while their Y-shaped ends form effective anchors to hold the wall in straight line and surface. As the stretchers are laid to break joint, the headers also are staggered, so that the ends of each Y in one course rest upon the ends of two Ys in the course below. This arrangement is indicated by the plan of alternate courses in Fig. 3. No dowels are used in these shear connections.

A departure from ordinary masonry construction is that the stretchers are not in contact for their full length, but have end bearings 7 in. long (see Fig. 2), the bottom being cut away between these bearings so as to leave a 1-in. space or slot. With this arrangement, a definite bearing at the joints is insured in case of irregular settlement of the wall. These slots, which serve to provide for drainage of the fill, are not noticeable in the completed wall, being concealed by the chamfered edges of the faces of the blocks.

The stretchers, 6 ft. long and 4½ in. thick, with an effective depth of 12 in., weigh about 320 lb. and contain 2¼ cu.ft. of concrete and 18 lb. of steel. The headers in this installation are 5 ft. 8 in. long, but for higher walls their length is 8 ft. They have a uniform spread of 3 ft., and weigh 360 and 430 lb. respectively; in the longer stretchers, the quantities are 3 cu.ft. of concrete and 27½ lb. of steel, while the shorter ones have 2½ cu.ft. and 23 lb. respectively. Short stretchers, having a lug at one end only, and a dowel hole in the other end, provide for filling out at corners or at angles in the face of the wall (see Fig. 3).

In the railway company's specifications a 1:2:4 concrete mix is required, using either crushed stone or washed and screened gravel for the coarse aggregate, with the minimum amount of water necessary to produce a plastic or workable mixture. A smooth float

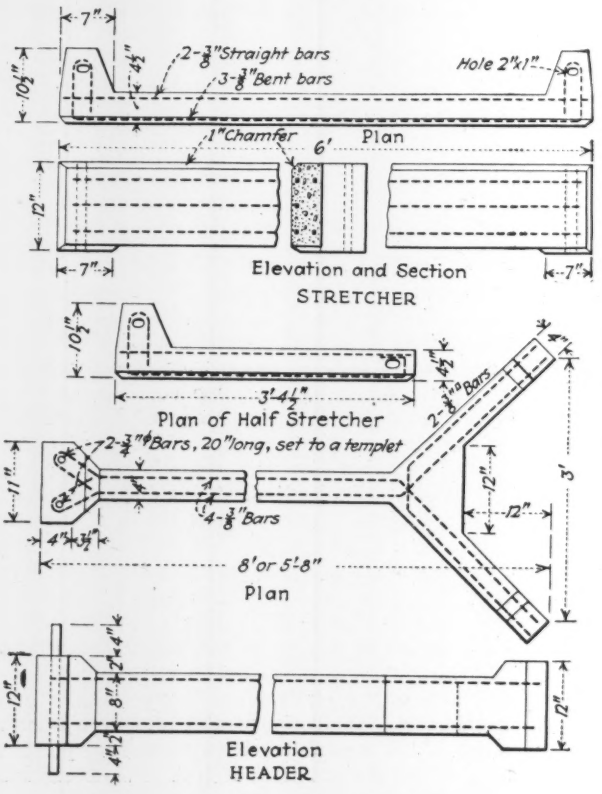


FIG. 2—MEMBERS FOR SOLID-FACE CRIBBING

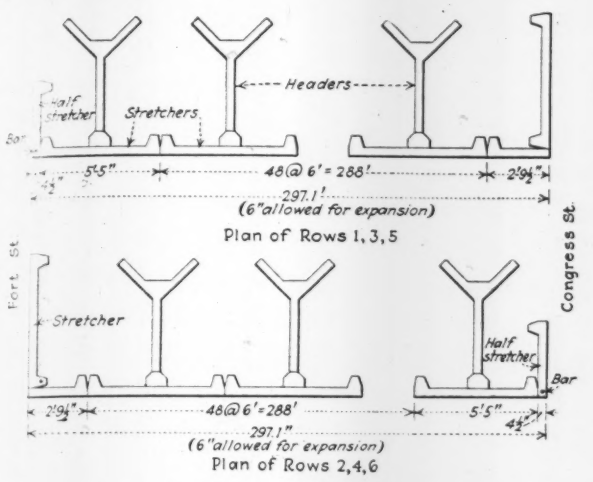


FIG. 3—ALTERNATE COURSES OF CRIBBING

finish is given to the face of the stretchers. The holes and dowels are spaced accurately in the forms by means of templets. Reinforcing steel consists of deformed bars, but the dowels are plain round bars. To protect the exposed parts of the latter from rust, these parts are dipped in a bituminous composition before the rods are set in the forms. The precast members were delivered in box cars, unloaded by hand and set in place by hand, without the use of a derrick.

This concrete cribbing construction is reported as being cheaper than poured concrete retaining walls of gravity or reinforced section. The precast concrete units for the cribbing of about 2,300 lin.ft. of wall were furnished by the Federal Cement Tile Co., Chicago, and were erected by W. E. Lennane, Detroit, general contractor for the track depression. This work is all under the direction of J. A. Heaman, chief engineer, Grand Trunk Ry., and F. P. Sisson, division engineer in charge of construction.

Open-Front Wall; Illinois Central R.R.—For the retaining wall of a Chicago track-elevation fill along

FIG. 4—OPEN-FACE CRIB WALL; ILLINOIS CENTRAL R.R.

property lines, where the wall need not be built to full height at present, the Illinois Central R.R. is using concrete cribbing, as estimates showed that it would be far cheaper to adopt this method than to build a solid retaining wall of full height at this time. Eventually such a wall may replace the cribbing, the latter being then removed. Economy in construction cost, complete interlocking of the cribbing and large amount of salvage were leading factors in the selection of this type of wall.

This crib wall, shown in Fig. 4, is built of interlocking members of I-beam section. As shown in Fig. 5, the headers or transverse members have T-shaped heads to fit into the longitudinal members or stretchers, which are laid flat. In general, the interlocking is relied upon to hold the members in place, but in order to insure firm bearings it was necessary in some cases to chip away the concrete or to use cement grout. No footing is built, the base of the crib work being laid in a shallow trench in the surface soil. This cribbing, which is being used for a length of about 1,955 ft. near 67th St., has a maximum height of about 10 ft. with a face batter of 2 in. per foot. It has a width of 4 ft. for the two lower and two upper tiers, and 6 ft. for the

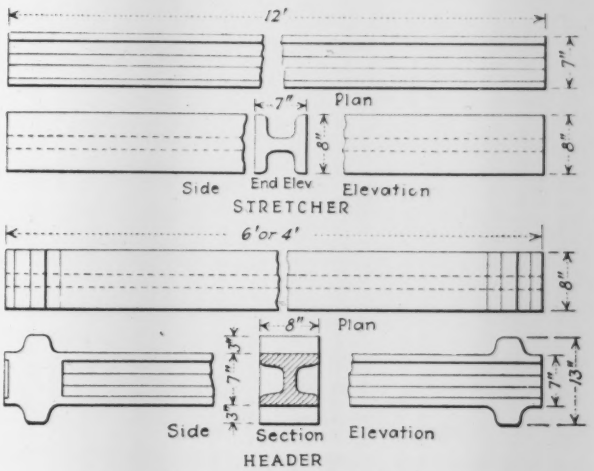


FIG. 5—MEMBERS FOR OPEN-FACE CRIBBING

remainder. The cribbing is sufficiently close to prevent much of the fill from material spilling through the openings in the face. It will be noted that the cribbing is built around the telegraph poles, which are thus left undisturbed. In construction, the cribbing was erected by hand at the rate of about 480 sq.ft. of wall per day; filling was deposited at the same time so as to anchor the lower part in position while the upper courses were being placed. This crib wall is one of the construction details of the extensive work being carried out under the railway company's Chicago terminal improvement organization. The crib members were supplied by the R. C. Products Co., Cleveland, Ohio, and the contractor for building the wall was the Ellington Miller Co., Chicago.

Other Concrete Cribbing—A type of interlocking concrete cribbing which was developed on the Chicago, Rock Island & Pacific Ry., consists of stretchers having mortised ends forming recesses to receive the flat T-heads of the headers. The stem of the header passes between the two stretchers, so that both stretchers and headers form the face of the wall. This crib wall construction, described in *Engineering News-Record*, Nov. 1, 1923, p. 718, has been used on track elevation work at Chicago and other cities. In the three types of cribbing above described, which are all patented, two have interlocking members, and one has the members put together with dowels which are cast in the concrete, so that this design also may be termed interlocking.

A simple and unpatented type of cribbing which has

been developed on the Chicago & Northwestern Ry. consists of concrete beams 6½ ft. long, of rectangular section, 8x8 in., each having three cored holes. Iron rods or drift bolts are set in these holes, which are grouted as the beams are built up or threaded on the rods. This construction, described in *Engineering News-Record*, April 3, 1924, p. 573, forms a solid instead of an open face, but differs from the solid-face cribbing on the Grand Trunk Ry. in that the headers extend to the face of the wall, alternating with the stretchers.

Determining Current Strengths in Tidal Basin Entrances

Formulas Based on Area of Basin and Range of Tide Found Useful in Planning Harbor Improvements

By H. A. Marmer
Chief Tidal Mathematician, U. S. Coast and Geodetic Survey, Washington, D. C.

In connection with projects involving harbor improvement or the bridging of tidal streams, it is frequently necessary to determine the strength of the current through the tidal basin entrance. If this tidal basin is not so extensive as to show considerable differences in the time of tide in different parts, a simple formula for the strength of tidal current through the entrance can be very easily derived from the area of the basin and the range of the tide.

Let A = low water area of basin;
B = high water area of basin;
r = mean range of tide in basin;
a = width of entrance at low water;
b = width of entrance at high water;
c = mean depth of entrance, from low water.

The tidal prism or quantity of water flowing in and out of the basin during a flood or ebb period is the volume of water in the basin above mean low water at the time of high water. Hence the volume of the prism is found from

$$P = \tfrac{1}{2}(A + B)r \qquad (1)$$

This water flows through an entrance the cross-sectional area of which at low water is ac and at high water is $ac + \frac{1}{2}(a + b)r$. Therefore, the mean cross-sectional area through which the tidal flow takes place,

$$S = \frac{4ac + r(a + b)}{4} \qquad (2)$$

A tidal cycle covering a complete flood and ebb averages half a tidal day or 12 hr. 25 min. In general it may be taken that the flood and ebb periods are equal, each being 6.21 hr. long. Hence from Equations 1 and 2 the average hourly velocity through the entrance for a flood or ebb period is,

$$V_a = \frac{(A + B)r}{3.105[4ac + r(a + b)]} \qquad (3)$$

The velocity of the tidal current, however, is not uniform during a flood or ebb period but varies closely as the ordinates of a cosine curve, the strength of the current corresponding to the maximum ordinate of the cosine curve that represents the velocity of the current. And since the maximum ordinate of a cosine curve is to the mean ordinate as $\pi : 2$, the strength of the tidal current through the entrance will be given by multiplying Equation 3 by $\pi/2$. Furthermore, the average velocity in a channel has been found to be about three-fourths that of the central surface velocity, the desired determination. Hence from Equation 3 the strength of the current at the surface in the center of the channel,

$$V = \frac{0.6745(A + B)r}{4ac + r(a + b)} \qquad (4)$$

If A, B, a, b, c, and r are expressed in nautical miles, V in Equation 4 will be given in knots or nautical miles per hour. If they are expressed in feet the following formula will give V in feet per second,

$$V = \frac{0.000187(A + B)r}{4ac + r(a + b)} \qquad (5)$$

In many cases the area of the tidal basin is practically the same at high water as at low water, and likewise the width of the entrance. In such cases Equation 5 becomes

$$V = \frac{0.000187Ar}{a(2c + r)} \qquad (6)$$

The above formulas give the velocity of the tidal current alone. Where a considerable amount of fresh water drains into the tidal basin the current due to the fresh discharge through the entrance will increase the velocity of the tidal current on the ebb and decrease it on the flood.

As an example of the use of the above formula, its application to Great Salt Pond, Block Island, may be cited. From Coast and Geodetic Survey Chart 276 the area of the tidal basin is determined as 0.75 nautical miles or 27,725,000 sq.ft. From the same chart the width of the entrance was found to be 600 ft., and the average depth, reckoned from mean low water, across the entrance, 16 ft. The tide tables give 3 ft. as the average range of tide around Block Island. It is therefore reasonable to assume that inside Great Salt Pond it will be somewhat less, say 10 per cent less, giving an average range for the tidal basin of 2.7 ft. Substituting these values in Equation 6 gives

$$V = \frac{0.000187 \times 27{,}725{,}000 \times 2.7}{600(32 + 2.7)} = 0.67 \text{ ft. per second.}$$

In 1915, in connection with some hydrographic surveys in the vicinity, a Coast and Geodetic Survey field party observed currents in the entrance to Great Salt Pond. From these observations the strength of the current for a mean range of the tide was determined as 0.4 knots or 0.7 ft. per second. The calculated velocity thus agrees very well with that observed.

It is to be observed, too, that the above formulas can be used for computing the approximate velocity of the current that will follow changes in the area of a tidal basin or changes in the width or depth of the entrance.

Court Reverses Itself in Aurora Zoning Case

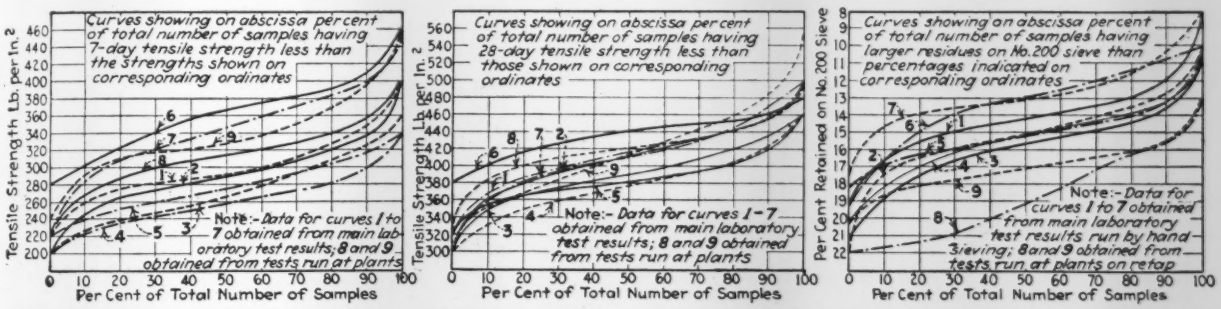
Doubts as to the validity of city zoning in Illinois, or at least its practicability, raised by the decision of the State Supreme Court in the Aurora case in February, 1925, were set aside in a decision by the same tribunal last December after a rehearing. The earlier decision did not rule against zoning directly but made it impracticable by ruling that the non-retroactive clause was discriminatory in that, in the specific case then up, it permitted a dozen grocery stores to continue in a residence section while barring additional stores (see *Engineering News-Record*, March 12, 1925, p. 455). On reconsideration, the court not only reversed its earlier decision as to the retroactive feature but came out strongly in support of zoning. The decision is reviewed in the March *National Municipal Review*.

Cement Specifications Changed By Missouri Highway Commission

Tests of Samples Showed that a Quality Inferior to That Generally Obtainable From the Mills Was Being Specified

In reply to a letter from "Engineering News-Record," F. V. Reagel, engineer of materials, Missouri State Highway Commission, has furnished the accompanying information on the changes recently made in the standard specifications for cement used by the commission. Mr. Reagel merely outlines the reasoning used by his department and does not intend that his statements shall be an argument for any particular line of action to be pursued by any other organization. —EDITOR.

CONSIDERABLE unrest in regard to existing cement specifications has been in evidence throughout the country for several seasons. In connection with the purchase of the cement requirements of the Missouri State Highway Commission for 1926, two changes were made in standard specifications: (1) A minimum tensile strength requirement of 225 lb. at 7 days was specified and (2) a provision was added to the effect that fluctuations in setting time causing finish difficulties in the field would be held cause for rejection.


Curves showing on abscissa per cent of total number of samples having 7-day tensile strength less than the strengths shown on corresponding ordinates
Tensile Strength Lb. per In.²
Per Cent of Total Number of Samples
Note:- Data for curves 1 to 7 obtained from main laboratory test results; 8 and 9 obtained from tests run at plants
Curves showing on abscissa per cent of total number of samples having 28-day tensile strength less than those shown on corresponding ordinates
Tensile Strength Lb. per In.²
Per Cent of Total Number of Samples
Note:- Data for curves 1-7 obtained from main laboratory test results; 8 and 9 obtained from tests run at plants
Curves showing on abscissa percent of total number of samples having larger residues on No. 200 sieve than percentages indicated on corresponding ordinates
Per Cent Retained on No. 200 Sieve
Per Cent of Total Number of Samples
Note:- Data for curves 1 to 7 obtained from main laboratory test results run by hand sieving; 8 and 9 obtained from tests run at plants on retap

CURVES SHOWING CEMENT QUALITY OBTAINED IS ABOVE THAT SPECIFIED, AND PRODUCTS OF MANY MILLS VARY
Curves are from test results of samples from 9 cement plants furnishing nearly 2 million barrels to the commission in 1925.

Bids were received from thirteen companies under the revised specifications, offering about 7 million barrels of cement, whereas the yearly requirement is approximately 1¾ to 2 million barrels. Three companies refused to bid under the revised specifications, on the grounds that any revisions to be made should come from national agencies and that the entire structure of standardization would be upset and the cement industry ruined if they agreed to furnish cement under any other specification than that already adopted as standard. The dissenting companies did, however, offer to guarantee that they would furnish cement averaging better than the requirements of the revised specification.

The changes made in the Missouri Highway Department specifications were for the purpose of meeting conditions existing in the state of Missouri. In past seasons, several cement producers have furnished cement barely meeting tensile strength requirements while the bulk of the cement offered for our work ranged well above specification requirements. Some trouble had been experienced by the contractors due to abrupt and excessive fluctuations in setting time within the specified limits.

In the opinion of the Missouri Highway Commission, no national agency is responsible for the quality of work obtained in the pavements and structures built for the Missouri tax payers. The commission is very much in sympathy with conservation and standardization movements, but has doubted very much whether it could afford to await the action of national agencies for relief from existing conditions. The changes in specifications have been adopted for one season, for the purpose of observing the results obtained, and will be subject to change or to final approval at the end of the season. Theoretically, the only sound procedure in the establishing of specifications is to so design specifications that the highest safe quality compatible with general economic production will be obtained. It would be very poor policy to specify a quality not economically obtainable and it is equally poor policy to specify a quality much inferior to the general quality economically available. As shown by the accompanying graphs, representative of the product of nine mills furnishing nearly two million barrels of cement during the year 1925, the commission found itself in the latter position under the old standard specifications.

Under the conditions imposed by constantly expanding highway programs and with traffic increasing at a still more rapid rate, the reduction of the curing period of concrete pavement is speedily becoming a very important consideration. It is found necessary, in an increasing number of instances, to allow traffic upon a new stretch of pavement a few days, a week, or ten days, under the normal curing period.

Mill practice in the cement industry has kept pace, in no small degree, with the requirements and needs of the engineer by changes in type of plant, storage, mixing of raw materials, and finer grinding. Since the beginning of the expanded highway program in Missouri, test records show a wonderful improvement in the quality of cement available in this district, but still the standard specifications remain on the old basis, preventing designers from taking into consideration the increased quality available because of the isolated cases in which the inferior or mediocre product must be accepted. Much attention has been given in the past to the improvement of the quality of concrete aggregates and to the design of proper concrete proportions. Engineers, as a rule, have assumed that no attention need be paid to variation in quality of cement above the minimum specification limits. A study of the graphs will give some idea of this variation.

Utilization by means of more selective specifications, of the better quality of cement generally available, will enable the engineer, in some measure at least, to design with greater economy and to route traffic over new work at the earliest possible time.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Tamper for Finishing Road Shoulders

By E. Christian Kanters
Civil Engineer, Coachella, California

FOR finishing concrete road shoulders on a 16-ft. black top road between Edom and Indio, Calif., the tamper here pictured was used. As the concrete was wet batch and hauled up to a maximum distance of four miles in ⅜-yd. trucks some heavy device was needed to accomplish the tamping effectively and quickly. The tamper herein shown is made of ⅜-in. x 1½-in. strap iron 3½ ft. long, separated by ⅝-in. washers and tied together by ½-in. bolts. To this grid are attached plow handles fastened as shown.

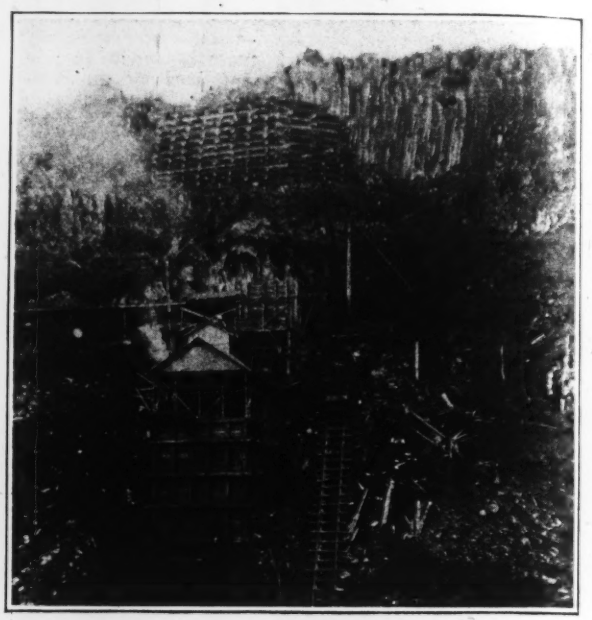
The shoulder is of such dimensions that a batch covers 13.8 ft. Expansion joints were placed in the shoulder at 30-ft. intervals. A crew of six Mexicans has averaged 300 ft. an hour, with a maximum 8-hr. run of 2,675 ft.

HOME-MADE TAMPER FOR CONCRETE SHOULDERS

Log Crib Protects Crusher Crew Against Falling Rock

IN BUILDING the diversion dam for Copco No. 2 hydro-electric plant in northern California the rock crusher and quarry were located on a steep slope surmounted by a vertical cliff of shattered columnar basalt. As the work progressed the basalt loosened, possibly as the result of blasting down below, and large fragments would frequently break off and bound down into the quarry and crusher.

As the falling rocks seemed to come chiefly from one particular location it was believed feasible to catch them before they got well started by building a rock crib close against the cliff. This was accomplished by using logs cut on the plateau behind the cliff and placing them with a derrick set up just back of the vertical face.



CRIB OF LOGS ABOVE AND CRUSHER BELOW

The logs were built up on a rock ledge in the form of a heavy crib extending about 20 ft. out from the face of the cliff. This crib was filled with rock as it was built up, thus providing ample weight on the horizontal tie logs for holding down the entire structure. The logs in the crib were held together with heavy cables. Cables were also passed up over the top of the cliff to anchorages behind the face.

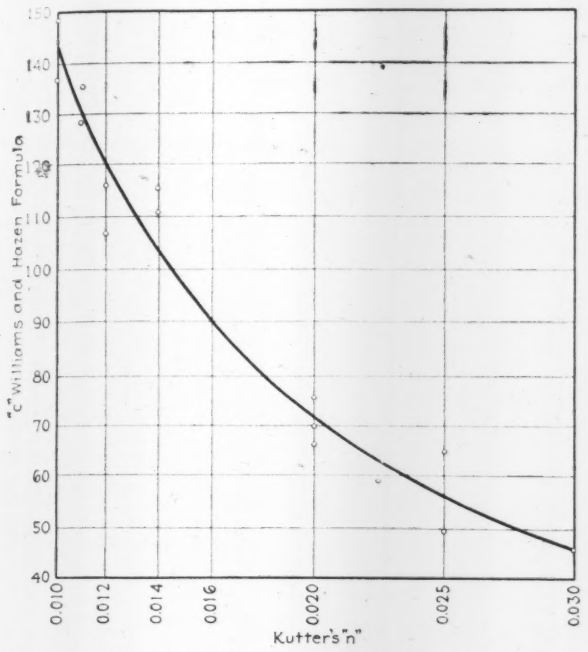
Adaptation of Slide Rule for Computing Flow in Pipes to Open Channels

By J. B. Lippincott
Consulting Engineer, Los Angeles, Calif.

THE Williams and Hazen slide rule has proven so convenient for computing flow in pipes that the writer has been investigating the possibilities of its use for computing flow in open channels also. The principal difficulty in so using it has been in the selection of values of "C" to correspond to the values of Kutter's n ordinarily used for channels. The accompanying curve showing relative values of C and n has been prepared to facilitate this portion of the computation. The relation shown is not claimed to be exact, but it is thought that values obtained by use of it and the Williams and Hazen slide rule will be sufficiently exact for most preliminary computations.

In determining the relation shown in the curve use was made of the experiments listed in Table No. 2 of "Hydraulic Tables" by Williams and Hazen, published by John Wiley & Sons in 1905. Values of C for a num-

ber of representative cases were taken from this table and corresponding values of n were selected from pp. 9 and 10 of "Hydraulic and Excavation Tables" published by the U. S. Reclamation Service in 1917, by comparison



APPROXIMATE RELATION OF WILLIAMS AND HAZEN'S "C" AND KUTTER'S "N" FOR OPEN CHANNELS

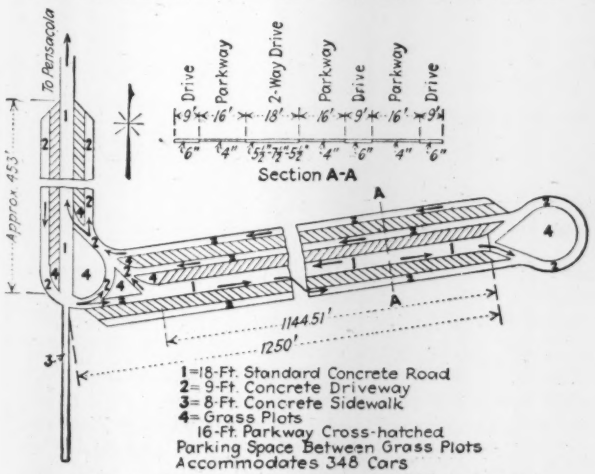
of the descriptions of the channel in each case. These values were plotted on cross-section paper and a smooth curve drawn through them.

Solving Parking Problem at Florida Gulf Coast Beach

By Winston E. Wheat
County Engineer, Escambia County, Pensacola, Fla.

THE "Gulf Beach Highway" in Escambia County, Florida, is an 18-ft. concrete paved road leading from Pensacola direct to the beach on the Gulf of Mexico. It is a development project financed by the county.

At the terminus of the highway the problem of



PLAN AND SECTION OF DRIVE AND PARKWAY

suitable parking space for automobiles presented itself. The soil, a typical beach sand, afforded no help. The cost of hauling from long distances would have made a clay or sand-clay treatment prohibitive both in initial and in maintenance costs. The solution adopted is a system of reinforced-concrete drives and parkways, with circular turns at the ends, shown herewith.

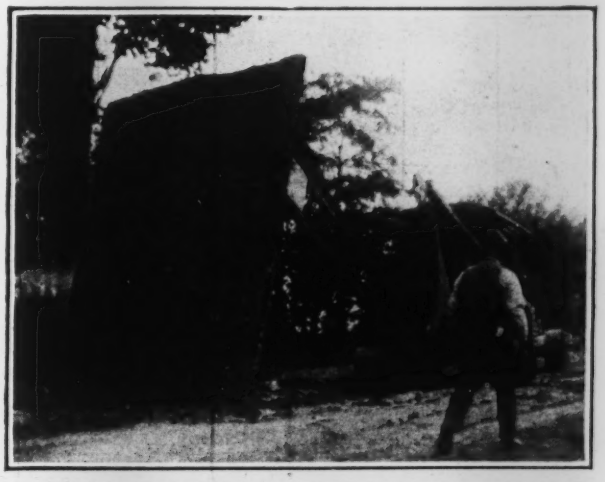
The layout, devised by the writer and associates, laid at Pensacola, in 1924, has been adopted by one beach in California and is planned for another point in Florida.

The central thought around which the design was built was avoiding any necessity of backing cars out into "live traffic" when leaving the parking space. A standard, two-way, 18-ft. drive was laid. On each side of this is a 16-ft. concrete parking strip, laid off with lines for diagonal parking. Then, a one-way concrete driveway, 9 ft. wide, is laid alongside the parking strips. A third 16-ft. strip, with the corresponding 9-ft. driveway, was laid on the north side. Circular drives of 12-ft. width, enclosing grass plots, are placed at each end of the parkway, and arrows painted on the concrete indicate the direction of traffic throughout. Curbs, 6 in. high, are placed at frequent intervals diagonally across the parking spaces to prevent their use as drives.

The two-way drive is of standard 18-ft. road design, 6.83 in. average thickness of concrete, reinforced with 44-lb. galvanized mesh. The 9-ft., one-way drives are of 6-in. concrete, reinforced with a galvanized mesh weighing 25 lb. per hundred sq.ft. The parking strips are of 4-in. concrete with 25-lb. reinforcing.

Excavator Used Effectively in Concrete Road Demolition

WITHOUT preliminary chipping or shattering of the concrete, a convertible excavator fitted with standard skimmer scoop equipment removed several thousand lineal feet of old concrete road which is being



EXCAVATOR RAISING SLAB FROM OLD CONCRETE ROAD

torn up preparatory to reconstruction near Barton, N. Y. Approximately 4.8 miles of concrete and old macadam was torn up preparatory to repaving with concrete. The old concrete slab was 6 in. thick and 9 ft. wide.

In handling the work, the skimmer bucket was thrust

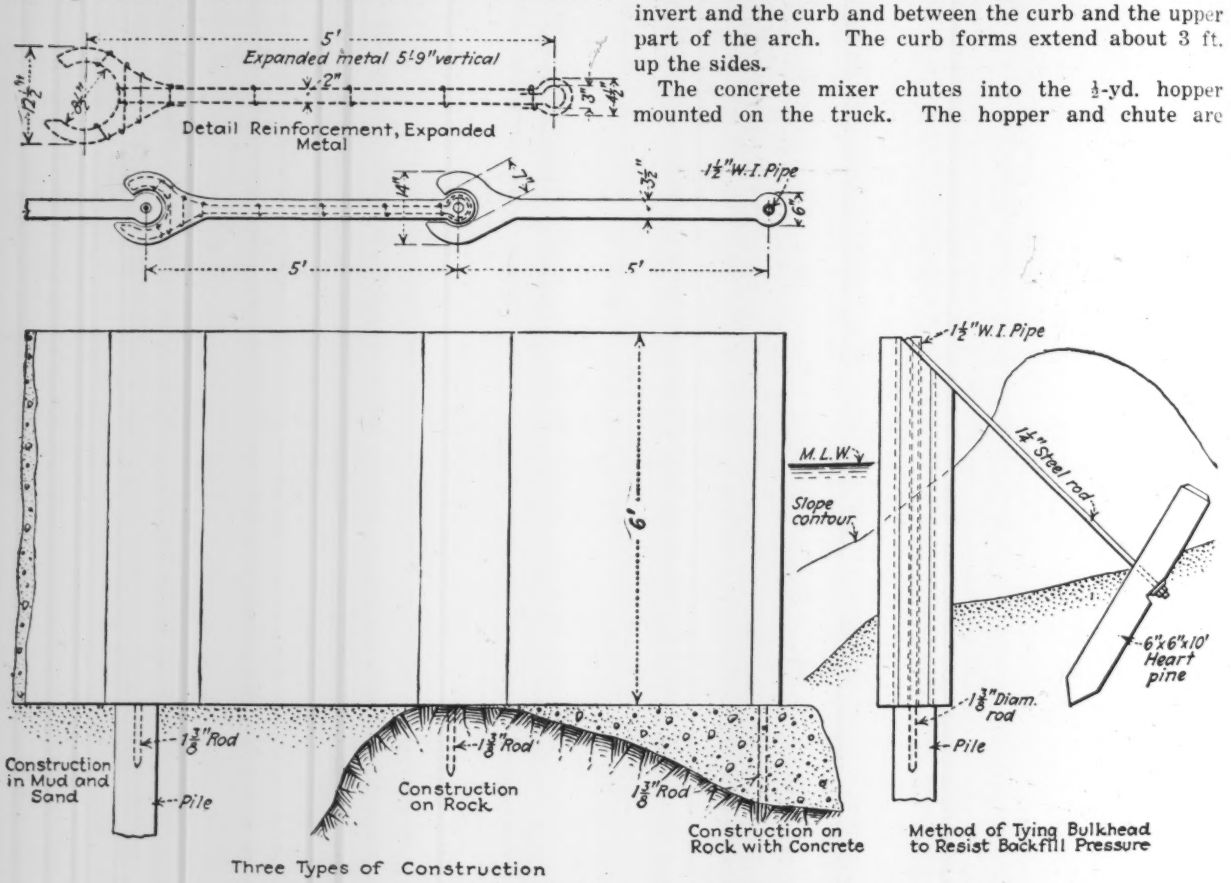
under the edge of the concrete and the boom was raised. When the slabs of concrete were worked up to a vertical position, the machine was propelled forward on its crawler mounting and the large slabs were tipped so that they fell over on the old pavement and broke into small enough pieces to handle. The entire job was handled by a ¾-yd. machine and from 80 to 100 lineal ft. of road were torn up and loaded per hour. The contractors on the work were DiPillo & Balistreri of Geneva, N. Y.

Information contained in this article is supplied by the Bay City Dredge Works, Bay City, Mich.

Bulkhead of Interlocking Gunite Piles

PRESHOT reinforced-gunite slabs have been used recently in construction of bulkhead walls at various points along the Florida Coast by the Riddle Co. of Palm Beach, Fla.

As shown in the accompany illustration, the interlocking sections are 5 ft. center to center and 6 ft. high.



CONCRETE BULKHEAD MADE UP OF LARGE INTERLOCKING SLAB UNITS
Each unit was formed by shooting concrete from a cement gun upon an expanded metal frame.

When placed the eyebar ends of slightly more than 1½-in. inside diameter are fitted with 1½-in. wrought-iron pipe. These pipe fit over 1⅜-in. rods driven either into the soft rock, embedded in concrete if concrete foundation is necessary, or into piling if the construction is in mud and sand.

Before this bulkhead is backfilled, 6x6x10-in. heart pine posts are driven the proper distance back of the bulkhead on an angle. Through these timber posts is run a 1¼-in. steel rod around the top of the 1½-in. pipe and the smaller encased rod. The rod is secured at the post end by a heavy nut.

The information contained in this article was supplied by the Cement Gun Co., Inc., Allentown, Pa.

Sewer Curb Concrete Carried by Truck Running Over Invert

THE necessity for completion of a part section of the Gooseneck combined sewer in Kansas City, Mo., before spring rains might hamper construction has resulted in the contractor's pouring the entire curb before the arch is concreted. To place curb concrete a Ford truck has been equipped with hopper and chute, as shown. The truck runs from the mixer, placed at strategic intervals on top of the bank, over the completed invert.

The Gooseneck sewer is a 21-ft. reinforced-concrete arch 16 ft. high of a special design permitting a thin invert. Construction joints are provided between the invert and the curb and between the curb and the upper part of the arch. The curb forms extend about 3 ft. up the sides.

The concrete mixer chutes into the ½-yd. hopper mounted on the truck. The hopper and chute are mounted on a swivel joint at the top of the tower and rotate together. The tower is made of structural steel angles riveted to the frame of the truck and is of such a height as to permit chuting the curb concrete to either side of the sewer. The truck was equipped complete in the contractor's blacksmith shop. As a rule the truck runs forward and backward between the mixer and the concreting point although it is possible to turn it completely around between the forms. The truck

CONCRETING TRUCK POURING CURB FORMS ON GOOSENECK SEWER, KANSAS CITY, MO.

driver places the chute in position and drives along slowly as the concrete runs into the forms. The contractor who devised and is using this truck is the Forson Construction Co., Kansas City, Kansas. Black & Veatch, Kansas City, Mo., are consulting engineers on the Gooseneck sewer.

Weight of Gates Shown Graphically

In the article on "Weights of Crest and Sluice Gates," by Donald C. Birrell, in *Engineering News-Record*, March 25, p. 499, in the chart showing graphical determination of weight of gates, inadvertently the zero of abscissas was moved twenty units to the right, with the result that for correct use of the chart 20 should be added to all figures at the bottom of the chart to give correct values as computed by the formula.

Job and Office Notes

The Revised Arkansas Standard Road and bridge specifications adopted by the Arkansas State Highway Commission, May 30, 1925, are printed in what may be termed the pamphlet form in lieu of either the bound volume or the loose-leaf system. Under this form the many disadvantages of the loose-leaf system are eliminated and the cumbersome bulk of the bound volume is avoided. At the present time, the full set of specifications is contained in twelve pamphlets, each pamphlet being devoted to some special phase of work. From time to time, additional pamphlets may be added, or any of the existing pamphlets revised, without making obsolete the pamphlets covering those items in which no change is intended. This latter point is a valuable consideration in itself due to the fact that highway specifications are being continually subjected to revision, as the results of research work are being promulgated into practice. The prepared set of specifications for any particular job will always contain three or more pamphlets, in addition to the cover sheet, one pamphlet being devoted to General Clauses and Covenants, another containing the requisite forms in the way of a Schedule of Pay Items and the Proposal, Contract and Bond forms, and the remaining pamphlets covering the specific work on which the proposals are being received. An additional saving in printing is effected through this method in that the sets of pamphlets, returned by the unsuccessful bidders accompanying their proposals, can be re-used, except the pamphlets containing the forms, in making up sets of specifications for other jobs.—W. W. ZASS, Little Rock, Ark.

Flat-Top Wooden Culverts Built Flush with the road surface have replaced the unsightly and more or less dangerous waterbreaks built on certain mountain roads in the Sierras in California. The old type of waterbreaks were built by the maintenance crews late in the fall, of material taken from the roadside, and essentially were mounds thrown transversely across the road. On the steep, unsurfaced mountain roads that are covered during the winter by a heavy blanket of snow the waterbreaks served a peculiar drainage requirement not met by the usual type of culvert. In the spring when the snow begins to melt, not from the top but from its contact with the ground, the water starts down the grade following depressions made by the last vehicle in the fall and quickly accumulates in volume and increases in velocity. Unless diverted at intervals, the flowing water will carry away the fine material of the road surface. The waterbreak intercepted this flow as well as that from the side ditch and diverted it away from the road. Last year two of the experimental flat-top culverts were built and they proved so successful that some 270 have been installed. They are ordinary wooden box culverts with tops built of three or four timbers 4x4 in. and spaced 1 in. apart. The top is set flush with and parallel to the grade of the road. Roadside drainage is carried through and surface drainage intercepted by the culvert. The top is removable to permit cleaning the culvert of fine material with which it may become filled during the course of summer maintenance.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

The Chief of Engineers on Drawbridge Closing

Sir—In your issue of April 1, in discussing the question of the bridges across the Hackensack and Passaic Rivers, you state in the editorial, p. 511, under the heading "Medieval Rights":

> "All the railroads are asking is that the the river be closed to high-clearance traffic for an hour or two in the morning and evening when these hundreds of thousands are going to or coming from work. This reasonable request has been refused time and again because the War Department has held that the ancient rights of the waterway must not be denied. Because medieval England traveled easiest by water, modern America en route across land must defer to water-borne traffic. * * The difficulty lies in the fact that the War Department, in its capacity as the federal supervisor of navigable water, does not consider itself an impartial judge of the relative rights of water and land-borne conflicting traffic so much as the defender of the waterway. It is not sufficient to prove to the Department that the total economies of the situation point overwhelmingly toward a restricted use of the waterway; the advocate of drawbridge closing will be turned down if the waterway interests make a slight case of interference with the free use of the channel."

The United States laws prohibit any obstruction to the navigable capacity of any of the waters of the United States unless affirmatively authorized by Congress; and they also prescribe that the draws of bridges crossing such navigable waters shall be operated "under such rules and regulations as, in the opinion of the Secretary of War, the public interests require."

In recommending the establishment of such rules and regulations, this department does not base its recommendation upon what medieval England did, nor does it turn down the advocates of closed hours for drawbridges "if waterway interests make a slight case of interference with the free use of the channel."

The question of the operation of the bridges over the Hackensack and Passaic Rivers has been before this department for many years. It is one of the most complicated and difficult bridge cases in this country to settle with justice to all concerned.

In 1902 regulations for operating the bridges were established by the Secretary of War after a most full and complete consideration of the rights and interests of both land and water traffic. Public hearings were held on the subject in 1903, in 1907, and again in 1918. The evidence adduced at these hearings has shown that the practical result of the closed hours desired by the commuters and the railroads would be to wipe out the use of the rivers for a very large part of the traffic purposes for which they are now used, to the financial embarrassment and possible ruin of the extensive industries along their banks. These rules now prescribe that during certain hours in the morning and evening periods, the draws shall not be required to remain open longer than ten minutes, nor permitted to remain closed longer than ten minutes to the exclusion of vessels approaching for passage. If no vessels are approaching, the draws of course remain closed and the land traffic is not interferred with. It would therefore seem that at no time should the land traffic be delayed for a period of more than ten minutes.

It is true that the land traffic is enormous, but, on the other hand, the water traffic is measured in volume by millions of tons, and in value by hundreds of millions of dollars. For 1924, the traffic reported for Newark Bay, Hackensack and Passaic Rivers—practically all of which is affected by the bridges—was 6,641,332 tons, valued at $250,268,023. The government has considered these waterways of sufficient importance to authorize projects for their improvement having an estimated cost of over $6,000,000. On these projects, about $4,000,000 has already been expended.

There has recently been submitted to Congress a report recommending the further improvement of the Passaic River above these bridges at an additional cost of $858,000. In this report, the following statement appears:

> "An economic study made by the Passaic River Improvement Association leads local interests to believe that the deeper channel requested would result in an increased commerce of some 500,000 tons. The advocates of this improvement state that a large part of the tonnage pertaining to the Passaic district is now brought in or taken out of New York Harbor by water. The direct exchange of this tonnage between water carriers would eliminate trucking and extra handling around New York, and delays at ferries, bridges, and in congested streets. It would also provide a quicker service for many commodities."

The larger part of the navigation passing through the bridges is dependent upon the tides for its movement. If additional closed hours are prescribed which would result in a vessel missing a tide in the morning, such vessel would be delayed until approximately the same hour in the evening, or at least so close that it would be prevented from passing the bridges that day. This might occur for a period of perhaps three days in succession, twice a month. The result, therefore, of a materially lengthened closed period might be disastrous to navigation on the river.

The importance of the water traffic is evidenced by the fact that strenuous opposition to proposed closed periods has been made by state, municipal and local interests, including, in 1918, the State Board of Commerce and Navigation, the Newark Board of Trade, and numerous transportation and commercial companies.

As long ago as 1903, a Board of Engineers which made an extensive investigation of the subject suggested, as a remedy, the reconstruction of the bridges crossing the rivers at such elevation as to give a clearance sufficient for the passage of barges and tugs beneath them at all stages of the tide. Such action would dispense with the necessity of opening the draws, except for vessels with masts or high upper works, and would thus very greatly reduce the number of openings. If the commerce on the river is to be maintained—and unless it is maintained a serious blow will be dealt to large interests which now depend upon the use of these rivers—the bridges must, sooner or later, either be raised or abolished and tunnels constructed. The land traffic will undoubtedly increase in the future; and if proper provision is made for water traffic, that will also increase. If it were, as you suggest, only a question of withholding a hundred tons of coal from a gas plant for an hour or so, or of requiring the crew of a garbage scow to wait fifteen minutes in the evening, there would be no problem—the closed periods would be established—but unfortunately for the commuter, whose only interest is a saving of a few minutes time, this is not the case.

H. TAYLOR,
Major General, Chief of Engineers.

Washington, D. C.,
April 13, 1926.

Why Cafeteria Water Supply Showed 1 P.p.m. of Free Chlorine

Sir—A number of months ago our Water Department received a call from the cafeteria of a local high school stating that they were having trouble with the silverware in the cafeteria and that they thought the tarnishing of the silverware was due to excess chlorine in the city's water supply. The city chlorinates some surface water supplies, but its major supply, coming from ground water sources, is not chlorinated and the water which is supplied to the high school was from ground water sources and therefore not chlorinated. We sent one of our inspectors out to the high school and he made an ortho-tolidin test of the tapped water in the high school cafeteria. This test showed 1 p.p.m. of free chlorine. Another test taken before the water entered the building, from a garden valve, showed no free chlorine. Upon checking up the matter, we found that the plumbers had carelessly tapped the cafeteria piping to the swimming pool circulating pipe and that water from the swimming pool had been used in the cafeteria for some weeks before complaint had been made. Apparently a serious epidemic

was avoided by over chlorination of the swimming pool water.

This incident shows the need for further regulation of piping upon premises having dual or contaminated water supplies. We are just now giving serious thought to an ordinance which would require any persons altering the water piping of premises having dual or contaminated supplies, to secure a permit to do so from the city health or plumbing inspection departments. We are also considering insertion, in this ordinance, of some provision requiring coloring or other identification treatment of all piping of contaminated supplies. WATER PURVEYOR.

March 16, 1926.

Steel Pipes on the Providence Aqueduct

Sir—With reference to the article entitled "Construction of Steel Portion of Providence Aqueduct" which appeared on p. 159 of your issue of Jan. 28, 1926, I would like to make the following comments: A 66-in. diameter pipe of ⅜-in. plate is frail to allow for corrosion, for a fairly large expected water-hammer and for joint efficiency. Besides these three requirements, the flattening effect due to filling and emptying a large steel pipe line throws a large moment into the pipe shell. The absence of stiffening angles is most reprehensible.

Also, a bend like that shown in the right-hand cut on p. 159 should have been provided with a proper concrete anchorage. Reliance on earth backfill does not give the positive action required. Even the bedding of the pipe line seems questionable—either a continuous longitudinal concrete support or else proper isolated saddles every 8 to 12 ft. would have been much better.

The "creepage" noted to be about "3 feet" should not have occurred at all in a properly designed pipe line.

Newark, N. J., AUSTIN H. REEVES.
February 2, 1926.

[This comment was referred to the author of the article, who replies as follows.—EDITOR.]

Sir—Referring to the comments of Mr. Reeves on my article: I notice that these are principally criticisms of design, for which I cannot claim the responsibility. The criticism, however, that "A 66-in. diameter pipe of ⅜-in. plate is . . . frail to allow for corrosion, a fairly large expected water-hammer and joint efficiency," can hardly be made unless Mr. Reeves has more information about the conditions than was given in my article. As I review the article, which was intended only as a description of construction methods, I find insufficient data to check the design and only by referring to other sources of information can I determine what allowance was made for the factors to which he calls attention. Without admitting for a moment that he is justified in his criticism, however, I would say that the proper coating, protection and handling of the pipe and the proper selection and placing of backfilling materials are so much more important than the question of the additional thickness which should be allowed for corrosion and other factors that the latter have little weight. I have known of cases where the steel shell was eaten away in a few months time, the pipe having failed to receive the proper coating and protection, and it is obvious that any allowance for corrosion under such conditions does not add appreciably to the life of the pipe. My opinion is that the $4 per linear foot that an additional ⅛ would have cost would be much better spent in improvements in the coating, if such were possible, and in the care in placing backfill.

Mr. Reeves refers to the "large moment" due to filling and emptying a large steel pipe. It is true that there are stresses in the pipe shell during the filling and emptying process which do not obtain at other times and also true that these stresses may be computed, but since the maximum stresses for which the pipe line is designed are due to a full pressure and much exceed those due to the weight of water during filling, is not believed that the latter are worthy of special consideration in design.

The earth bedding washed into place with water is believed to be superior to any concrete support in that it gives a continuous and uniform bearing with sufficient elasticity to allow for the movements due to temperature stresses.

Mr. Reeves' comment to the effect that the "creepage of about 3 ft. should not have occurred at all in a properly designed pipe line" indicates that he failed to read carefully the sentence in my article in which the creepage is mentioned. The word "creepage" was used to designate the difference in length between the pipe as laid in the field and that shown on the shop drawings, and is a question of fabrication rather than of design. The individual lengths shown on the drawings as 30 ft. 1 in. center to center of rivet holes were found to measure over ⅛ in. long; which difference, being cumulative, accounted for the difference in stationing as mentioned. BAYARD F. SNOW,

Salem, Mass., Now Resident Engineer, South
Feb. 17, 1926. Essex Sewerage District.

Municipal Associations of Engineers

Sir—In the hope, through your publication, of reaching engineers throughout the country who may not have heard of the activities being waged in behalf of professional engineers in general, may we ask that you give space to this letter.

Several years ago an organization was formed in New York City, with membership recruited from technical engineers in the employ of the state and city of New York and the counties and commissions of the state. It is known as the Association of Engineers of New York and its objects are:

1. To inform public officials, legislative bodies and civic organizations of the value to the community of the work being performed by engineers.
2. To advise the public of the technical training and experience required of the professional engineer.
3. To secure for those engaged in engineering work a compensation commensurate with the services rendered.

To make these activities country wide and uniform in character, a meeting was recently held in New York City, attended by representatives of engineering employees of Chicago, Boston, Philadelphia, Baltimore and New York, at which a plan of action was agreed upon sufficiently broad in scope to embrace engineers throughout the country.

Engineers in federal, state, municipal or private employ who have not heard of this movement but who desire to be associated with it may obtain information regarding it by applying to the undersigned.

215 Montague St., FRANK O. SCHELLENBERG.
Brooklyn, N. Y., Chairman, Membership Committee,
Feb. 26, 1925. Assoc. Engineers of New York.

Sir—The question of adequate remuneration for men in the engineering profession is occupying the attention of groups of engineers throughout the country. Significance attaches to the attempt made in some places to solve the question in a more direct way than heretofore. Organizations of a more or less permanent nature have been formed in some of the larger cities, the whole movement seeming to signify that engineers are becoming "fed up" on discussions of ethics and procedure and are demanding a policy and program with sufficient vigor to get results.

The lack of appreciation by the public of the value of engineering service is most apparent in the larger cities where safety, convenience, health and life itself are dependent upon the services of these men. Engineers know that the value of their work is out of all proportion to their salaries, and, furthermore, that their services are indispensable.

Recognizing that the problem can be met only by concerted and organized effort, the men in the engineering department of the city of Los Angeles organized the Los Angeles Municipal Engineers Association. Its purpose is to be instrumental in securing better salaries; aid in matters of sick leave allowances, civil service ratings, efficiency records, etc., promote harmony in the department and a spirit of loyalty; and raise the standard of efficiency throughout. The membership now numbers well toward eight hundred. Interest is spreading and inquiries are coming from engineers in other cities of Southern California regarding the possibility of affiliating with the Los Angeles Association.

The need for such an organization becomes more apparent each day, and there seems to be no reason why it connot be of value both to the men in the service and to the administrative heads of the department as well.

Los Angeles, Calif., CARL HAGUE,
March 10, 1926. Secretary, Los Angeles Municipal Engineers Association.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Propose an International Standardizing Body

Delegates from Many National Bodies Discuss International Standardization

Standardizing officials from 17 foreign countries met in New York during the past week with representatives of the American Engineering Standards Committee as the Third International Standardization Conference, for the purpose of discussing the formation of an international committee or association to deal with problems of international standardization. The delegates reached a generally favorable conclusion as to the desirability of forming a permanent international body, and discussed details of the proposed organization and system of procedure for report to the several national standardizing bodies which they represent.

Many Foreign Delegates

The delegates attending the meeting are: P. Brettschneider, Austria; E. Uytborck, Belgium; R. J. Durley, Canada; V. List and B. Rosenbaum, Czechoslovakia; G. J. Darrieus, P. Girault and E. Roth, France; Otto Kienzle and A. Maier, Germany; L. B. Atkinson, R. E. Crompton, Sir Archibald Denny, Sir Richard Glazebrook, P. Good, C. le Maistre, and C. P. Sparks, Great Britain; W. H. Tromp, Holland; N. Ratti, Italy; M. Y. Inomata and Shoji Konishi, Japan; K. Heiberg, Norway; P. Drzewiecki and A. Roginski, Poland; M. Chatelain, M. Lapiroff-Scoblo, and M. Zischievsky, Russia; A. F. Enstrom, A. Kruse, and S. E. Osterberg, Sweden (and representing also Denmark and Finland); C. Hoenig, Switzerland; P. G. Agnew, G. K. Burgess, and C. E. Skinner, United States.

International standardization has been successfully handled up to the present by informal correspondence between national standardizing organizations, by the organization of joint committees in one or two cases, and by the International Electrotechnical Commission, the latter dealing with scientific and technical nomenclature of the electrical field, rules for power rating, terminal marking, and other important matters of uniformity of practice, and lately also with prime movers. Successful work has been done by these methods on screw-thread systems, on dimensions of ball bearings, and some other basic elements of mechanical industry, and work is now in progress on the dimensions of nut and bolt heads with respect to wrench fits, and on several other important projects.

A few months ago officials of the British Engineering Standards Association in co-operation with the Dutch and Belgian groups presented a definite proposal for the formation of an international body. This was transmitted to each of the 20 existing national standardizing bodies throughout the world and has been fully discussed by them. The proposed organization is planned to be independent of the International Electrotechnical Commission for the present, though it may ultimately absorb the latter.

Uniformity in Design

Separately from this subject, the conference also dealt with international uniformity in screw threads, bolts and nuts, limits and fits for interchangeable manufacture, gears, and "preferred numbers." In the matter of sizes of boltheads and nuts, experiments are in progress in England which are expected to lead to recommendation of smaller nuts and boltheads. In the conferences dealing with screw threads the possibility of arriving at a compromise between the Whitworth (British) and the American standard screw thread was discussed. A compromise thread has been proposed with a thread angle of 57½ deg. (halfway between the Whitworth 55-deg. and the American 60-deg. thread) and would have the top and root truncate different from both, with the effect of making a bolt of the new thread fit a nut of the others, and traversely. The conference adopted a resolution expressing the desirability of inquiring into its adoption.

Engineering Fifty Years Ago

From *Engineering News*, April, 1876

THE first locomotive in China has made a trial trip of one mile on a tramway near Shanghæ.

* * *

The first and only iron bridge on the Pacific coast was opened to travel on the 18th of last month at Santa Rosa, Cal.

* * *

Work on the new Welland Canal is again in full blast. The contracts require that the canal shall be completed this year, but it is extremely doubtful if the line will be in readiness by the time specified, as much remains to be done at the Lake Erie end. The harbor at Port Colbourne must be deepened and the pier extended, and this kind of work cannot be hurried.

The excavation must be made in solid rock, from 14 to 18 ft. under water. It is the intention to furnish 14 ft. of water at all points, except over the miter-sills on the levels, where the water has to be raised. Here the depth will be only 12 ft.

Report Favors Bridge Over Lake Champlain

New York State Commission Reports on Five Sites—Tolls Expected to Repay Cost Quickly

Strong advocacy of a bridge across Lake Champlain is contained in the report of the legislative commission of New York State which was noted in our issue of Apr. 15, p. 626. The study was made in conjunction with a Vermont commission. It was found that the traffic which would use the bridge is sufficiently large that a moderate toll rate would not only pay the annual charges on a bridge but would retire the cost in less than 15 years. No definite recommendations on location or type of structure are made, however, because subsoil conditions are not yet known; the commission therefore recommends an appropriation of $25,000 for making borings at the different sites, a final report on location and plan of procedure to be based on the results of the borings.

Lake Champlain forms the boundary between New York and Vermont for a distance of 112 miles, from Whitehall to Rouses Point. Seventeen ferries are operated across the lake in this distance, but they give only six months' service, 12 hr. a day. The regions on east and west shores of the lake are therefore largely without means of intercommunication, and numerous important lines of travel between the northern part of New York and upper New England are interrupted, so that traffic is subjected to much inconvenience and long detours.

Six Possible Locations

For a length of 75 miles the lake is too wide for bridging, but in the narrower sections south of Port Henry and at Rouses Point and Alburg, at the northern end, the construction of a bridge is feasible. A movement for a study of bridge possibilities crystallized within the past two years and ultimately brought about the appointment of the two commissions. These bodies jointly studied a number of sites, and name as the most important five locations at the southern end of the lake and one at the northern end, as follows:

From Fort Frederick, N. Y., to Chimney Point, Vt., 1,629 ft. between shores; low-level bridge with draw span.

From Crown Point, N. Y., to West Bridport, Vt., 1,410 ft.; low-level bridge of three spans including a draw, and a long embankment at the west end.

From Fort Ticonderoga, N. Y., to Larrabees Point, Vt., 2,450 ft.; low-level bridge of five spans with draw, and long embankments at both ends.

From the old fort at Ticonderoga, N. Y., to Mount Independence, Vt., 1,844 ft.; high-level bridge of eight spans (320-ft. channel span with vertical clearance of 90 ft.)

From Wright's, N. Y., to Chipman's Point, Vt., 1,282 ft.; nine-span high-level bridge (220-ft. channel span.)

(At the northern end of the lake) from Rouses Point, N. Y., to West Alburg, Vt., and thence by a second bridge to the Ver-

mont mainland at Swanton, respectively 5,150 ft. and 4,345 ft.; eleven spans of 125 ft. with long terminal embankments, and three spans of 100 ft. with draw and long terminal embankments would be required here. A bridge at this crossing might be built as a joint railroad and highway bridge in co-operation with the Rutland R.R. and the Central Vermont R.R., both of which are said to be interested and ready to participate.

Cost estimates based on assumed foundation conditions range (for bridge structure only) from $548,000 to $921,000. Operation and maintenance is estimated by the state engineer at $5,700 per year for a fixed bridge and $16,500 for a bridge with draw span.

HIGHWAY TRAFFIC INCREASING

Traffic statistics show that 75,000 automobiles crossed the lake ferries at the southern end of the lake during the summer season of 1925. Data from traffic on roads, at toll points and other stations in the neighborhood of the lake indicate an annual increase of traffic of 8 to 15 per cent during the last two or three years. The commission further believes that the cross lake traffic would be increased by 25 per cent immediately by the opening of a bridge, and that the first five years of the bridge would show more than 50 per cent increase above last year's vehicle traffic across the lake. Present ferry toll charges range from 50c. to $1 per car. Placing bridge tolls at half the present ferry tolls, a bridge might be expected to pay for itself in 13 years without taking account of increase of traffic. The commission concludes that "One, perhaps two bridges—one in the southern portion of the lake and one near Rouses Point—would be economically justified," and that "unwarranted hardship and deterrent are being imposed upon interstate vehicular traffic by the lack of bridge crossings."

No attitude is taken by the commission on the question of whether the bridge should be built as a public free bridge, a public toll bridge, or a private toll bridge, though the three types of procedure are briefly discussed in its report.

Land for Timber Production Added to U. S. Forests

An important step in the national forest policy was inaugurated recently when the National Forest Commission authorized the purchase of forest land for timber production under the authority of a recently enacted law. Heretofore lands have been purchased only for stream protection. Under the new law, the commission is enabled to purchase land in the lake states and in the pine region of the southern states. Altogether, the commission has authorized the purchase of 83,205 acres as additions to the eastern national forests.

Arlington County, Virginia, May Get Water from Washington

Authority to supply water to the Arlington County Sanitary District, Virginia, from the District of Columbia has been granted to the Secretary of War in a Congressional bill signed by the President on April 15.

Damage to Ludington Breakwater

In connection with a picture of the outer end of the Ludington Harbor breakwater, published in our issue of April 8, 1926, p. 587, it was stated that the picture showed the effect of recent storms upon the breakwater. This statement was in error. The photograph showed the condition of the breakwater in February, 1924. During the summer of 1924 the outer end of the breakwater was reconstructed by the S. M. Siesel Co. under plans prepared by the U. S. Engineers and we have been advised by the superintendent of lighthouses at Milwaukee that the reconstructed breakwater was not damaged in the storms of the past winter.

Los Angeles Plans to Build Refuse Incinerator

Bids were opened in Los Angeles on April 7 for a garbage incinerator designed to burn 200 tons of refuse in 12 hr. with alternative bids on a capacity of 400 tons in 12 hr. The doubled capacity was considered because of the possibility that the present contract with the Fontana Farms Co. might somehow be broken, making it necessary to divert garbage from there to the incinerator. The material to be burned is specified as 65 per cent wet garbage or its equivalent, and 35 per cent ordinary rubbish.

Six bids were received which ranged, for the 200-ton plant, from $174,500 bid by the Superior Incinerator Co., Dallas, Tex., to $655,000 by the Decarie Incinerator Corporation, New York City, and for the 400-ton plant from $318,000 by the Hiler Engineering & Construction Co., Brooklyn, N. Y., to $747,000 by the C. O. Bartlett & Snow Co., Cleveland, Ohio, the Decarie Corporation not bidding on the larger installation.

Chicago Votes Big Bond Issues

By a large majority the city of Chicago on April 13 voted in favor of bond issues totaling $19,070,000, of which it is estimated that $11,300,000 will be spent during 1926. The largest item is $12,545,000 for street widenings, principally to complete important projects already started or to improve main thoroughfares; of this amount about $8,500,000 will be spent in 1926. Bridges amount to $2,500,000, of which $1,500,000 is for a Calumet River bridge at 106th St., and $200,000 for preparing plans for new bridges which will be required when the straightening of the Chicago River is carried out. About $600,000 will be spent this year. Bonds for street lighting and fire engine stations total $2,250,000 and $1,475,000 respectively, with $1,500,000 and $550,000 for 1926. For city yards in several wards, about half of the $300,000 bond issue will be spent this year. In addition, the people voted favorably on the proposition for a tax for a municipal zoological garden in the forest preserves at Riverside, land for which will be donated by the owner. The cost is estimated at about $4,000,000 for park and buildings, but construction will not be begun until next year.

Hard Rains Damage and Delay Work on California Dams

The heaviest April rains in the history of the local weather bureau fell early this month in Southern California, damaging highways and construction work generally, notably several dams under construction in Los Angeles County.

At the Pacoima flood control dam where foundation excavation has not yet been completed, the precipitation, reported as 5½ in. in 24 hr., brought down debris that partially filled the excavation and covered construction equipment to an extent that will cause an estimated delay of 30 days. Damage estimated at about an equal amount occurred at the Big Santa Anita dam where some concrete had already been poured. The most serious damage to the County Flood Control work, however, occurred at Puddingstone dam, an earth fill now in the early construction stages, which was overtopped, despite full flow through a 7x9-ft. bypass tunnel, with the resultant loss of some of the work already completed.

Reports from the vicinity of Puddingstone dam gave the rainfall as 5 to 8 in. in 24 hr. with a peak of ¾ in. in 20 min. In the mountains above rainfall for the storm is reported to be as much as 16 in.

In the central part of the state near Halfmoon Bay, a 50-ft. privately owned earth dam used to store water for irrigation was overtopped during this same storm and swept away with some damage to farm property in the path of the flood.

Create Department of Engineering for Westchester County, N. Y.

Governor Smith has signed an act creating the department of county engineering, to take the place of the office of county superintendent of highways in Westchester County, N. Y. The county engineer is to be appointed for a four-year term by the county board of supervisors and may be removed by the board "for malfeasance, or malfeasance in office, inefficiency, neglect of duty or misconduct in office after an opportunity to be heard is given." He must be a "civil engineer with qualifications which would entitle him to become a full member of the American Society of Civil Engineers." Besides having all the powers and duties "prescribed by law for county superintendents of highways" the county engineer shall have whatever other powers and duties as may be required by the county supervisors.

New Transit Commissioners for New York Appointed

Governor Smith of New York State has appointed three new transit commissioners to replace the present commissioners whose terms have expired. The new commissioners are John F. Gilchrist, Charles C. Lockwood and Leon G. Godley. Under the state reorganization plan the transit commission will become the metropolitan division of the public service commission.

WASHINGTON NOTES

IDENTICAL bills have been introduced in the Senate and House of Representatives by Senator Sheppard and Representative Connally, both of Texas, providing for extensive highway research by the Corps of Engineers. Representative Connally states that this is done to provide some competition between government agencies in research work pertaining to highway improvement. He declared that the research division of the Bureau of Public Roads seems to have gotten into a rut. There has been such a dearth of accomplishments in the improvement of types of roads that he feels that good would result were another agency to study such problems.

At the Corps of Engineers it was made very clear that the proposed legislation was not inspired there. The feeling at the Bureau of Public Roads is that its research work has been conducted efficiently and has justified many times over the amounts expended.

NINE bids for the Muscle Shoals properties of the government were submitted to the joint congressional committee before April 10. The committee has announced that five of the nine bids are being considered. They are the bids of the following companies and individuals: The Union Carbide Co.; The American Cyanamide Co.; The Muscle Shoals Power Distributing Co. and the Muscle Shoals Fertilizer Co.; Frederick T. Hepburn, Elon H. Hooker and associates. The other bids which were submitted, but which do not come within the requirements, are those of F. E. Castleberry, Shreveport, La.; Lloyd H. Smith, of Battle Creek, Mich.; C. E. Graff, of the American Nitrogen Products Co., Seattle, and James F. Levering, Washington, D. C.

In its statement announcing the names of those who had submitted bids, the committee stated that the offer of the Muscle Shoals Power Distributing Co. and the Muscle Shoals Fertilizer Co. was made in behalf of a group of public utility companies.

The bids have been referred to the interdepartmental advisory committee consisting of Dr. F. G. Cottrell, director of the Fixed Nitrogen Research Laboratory; Dr. Elwood Mead, the commissioner of reclamation; General Harry Taylor, the Chief of Engineers; and Paul Clapp, an electrical engineer on the staff of the Secretary of Commerce.

Thomas W. Martin, in his capacity as president of the Muscle Shoals Power Distributing Co., made public the following statement: "The details of the proposal submitted by the affiliated power companies of the South can not at this time be made public, of course, but it ought to be said that that proposal recognizes the primary importance of leasing the properties for private operation to guarantee adequate production of nitrogen, first as a measure of national defense, second as a benefit to agriculture through the manufacture of fertilizer, and third the distribution of surplus power to the public under regulation."

Gale Produces Severe Heat in Newport Fire

Fire in Newport, Ark., Sweeps Thirty Blocks—Much Damage to Concrete Sidewalks

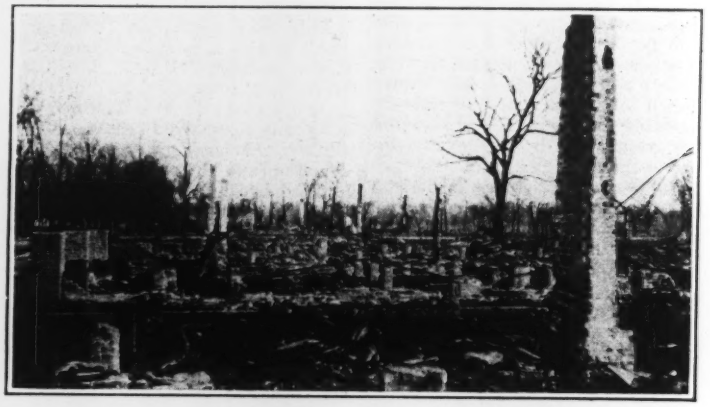
Thirty city blocks were swept by fire in Newport, Ark., on March 1, during a high gale. Some 300 houses, 400 outbuildings, and several stores and two large lumber and stave mills were burned, a total property loss of about $1,500,000. Fortunately only one life was lost. The blower action of the wind caused the fire to develop unusual heat effect. Albert S. Fry, of the Morgan Engineering Co., Memphis, reports that even humus in the top soil was burned away in many places, that tops of concrete sidewalks popped off in good-sized patches under the action of the heat, with loud shotlike reports, that window panes were melted and steel plumbing pipes twisted and warped into odd shapes.

Fire started about 1.30 p.m. in a hay barn near the northern edge of the town. The wind velocity is estimated at 50 to 60 miles per hour. The fire spread to a nearby lumber shed, jumped across a concrete levee wall 8 ft. high into some old frame residences, and thence into a large shed filled with cypress staves, and from here leaped across a 6-ft. concrete levee wall and across an open space of 220 ft. to the main part of the town, through which it burned until it reached the open fields on the south boundary. It lasted only about 3 hr. The wind was so strong that it flattened the flames to a nearly horizontal position.

A factor in the early extension of the fire was the stave shed already mentioned. This consisted of a corrugated iron roof supported on wooden posts about 15 ft. high, and had sides and ends open. In this area of 20x350 ft., staves were piled in cribwork fashion to a height of 12 and 14 ft., which presented ideal conditions for a hot fire. When the piles of staves were well aflame, the air was filled with burning staves which carried the fire to one building after another.

Only seven houses within the boundaries of the burned area were saved. Of these, one is of brick and the others of frame construction. One of the frame houses has a wood shingle roof, the others asphalt shingle roofs. However, Mr. Fry notes that a fireproof roof did not insure protection, as one house with tile roof and copper valleys, which was safe when staves landed on the roof and burned to ashes, caught fire below the roof and burned out; also, a brick garage with tile roof was destroyed. On the night after the fire, the town council passed an ordinance requiring fireproof roofs on all future buildings.

The water supply of the town was seriously impaired by heavy draft, though it did not entirely fail. In some cases fire hose coupled to a hydrant was burned while the water was running in the hose, and when this happened it was impossible to turn off the water. Practically everybody turned on garden hose connections, and these were not turned off when the fire forced the people to abandon efforts to save their property. The water supply is taken from White River, through a filter and clearwater tank, and had no bypass direct from the river to the pump. The town has only one fire truck, which is sufficient for ordinary service but was almost powerless in this instance. Some help was obtained from two fire trucks sent by neighboring towns. At best, however, they could protect only along the borders of the fire area.



FIRE RUINS ALONG ONE OF NEWPORT'S STREETS

Geological Congress at Madrid

The fourteenth International Geological Congress will be held at Madrid, Spain, May 5 to June 12. Geologists and engineers from the United States, Great Britain, Belgium, Denmark, Mexico, and many other countries will attend. It is expected that the total registration will be over one thousand delegates.

From May 5-22 excursions of a geologic, industrial, and artistic nature, have been arranged to Sevilla, Morocco, Rounda, Huelva, Cordoba, Burgos, and the Canaries. During the congress there will be other geological trips about Spain and to the various islands.

D. F. Hewitt, M. S. Goldman, and H. C. Ferguson, of the U. S. Geological Survey will be the American representatives.

Road Exhibition to Be Held in Milan, Italy

The Third International Road Exhibition to be held at Milan, Italy, from September 1 to 20, 1926, during the Fifth International Roads Congress, will occupy about 25,000 square meters of the permanent grounds of the Milan International Sample Fair, according to the Transportation Division of the Department of Commerce. The committee organizing this exhibition is inclined to give American exhibitors every possible facility. Actual allotments of space will not be possible until about June, when it is expected the committee will find it easier to figure the general space requirements. Copies of the program, rules and regulations, and application blanks may be obtained from the transportation division or through the district and co-operative offices of the Bureau of Foreign and Domestic Commerce.

Realtor and Ex-County Judge for Manager of Kansas City

On April 10 a new form of city government was inaugurated at Kansas City, Mo., the council-manager form of government being substituted for that of a mayor and two houses of the city council. The manager is described as a "life-long" member of the political party that has a majority of one in the council-elect. He has been a Kansas City realtor since 1895. He has been member of the City Plan Commission of Kansas City; was elected county judge in 1922 and defeated for re-election in 1924—going down with other members of his political party, now again dominant.

The new director of public works is Matthew S. Murray formerly engineer in charge of surveys and plans, Missouri Highway Commission. Willian F. Fleming is director of the department of water.

Enabling Act Passed for Elevated Highway at New York City

An act authorizing the city of New York to adopt a plan for and to construct an elevated public highway from West 72nd St. to Canal St., a distance of approximately 4 miles, along or near the water front of the Hudson River, has been signed by Governor Smith. The plan is not to be adopted until after all interested parties have been given a hearing. After it has been adopted the city shall acquire by purchase or condemnation the easements and property necessary for the highway and approaches and shall determine what portion of the cost shall be paid by taxes on the entire city or one or more of the boroughs. The board of estimate of the city then may authorize the president of the borough of Manhattan to construct and pave the elevated highway. Also, it is empowered by the act to issue bonds or corporate stock to defray that portion of the cost of construction and purchase of property which it may determine shall be borne by the city.

Engineering Work Centralized Under Proposed Seattle Charter

A short ballot, a weak mayor, a strong council, a "city business manager" in control of engineering public works and utilities and fire protection, a single health commissioner, and a half dozen commissions, including one in charge of the police department, are the main features of the outline of the new charter for Seattle, Wash., announced by the recently created charter commission (see *Engineering News-Record*, March 18, p. 462). The only elective officers would be the mayor, comptroller, treasurer and corporation counsel and 14 councilmen, all elected at large but with the council chosen to represent seven districts. All department heads and commissions would be appointed by the city council, with the possible exception, yet to be determined, of the civil service commissioners.

Manager's Control Limited

The "city business manager" would be "head of the administrative department of the city" but by exception and specification his functions are limited as stated above. His department has eight divisions, each with a head appointed by him: (1) engineering; (2) power and light; (3) water; (4) transportation; (5) fire protection; (6) buildings; (7) streets; (8) harbor. (Seattle owns an extensive street railway, light and power systems and harbor improvements.) The manager would be subject to the recall provisions of the State law applicable to elective officials.

Departments outside the control of the city business manager, with the number of commissioners in charge of each, are: Police, 3; park, 5; library, 3; civil service, 3; health, 1; city planning (advisory), 21; welfare, 7.

No compensation would be given to park, library, planning and welfare commissioners. The pay of the other commissioners and of the manager is left to the determination of the council. Councilmen would be paid not over $1,000 a year, the figure to be fixed later by the charter commissioners. The mayor would receive $7,500 a year.

The only real powers vested in the mayor are incident to his being a member and ex-officio president of the council but as such all he can do, beyond the usual powers of a presiding officer, is to cast a tie vote and to demand reconsideration of any ordinance which has been passed or rejected (except those submitted by initiative petition or classed as emergency). His demand for reconsideration must be made in writing, within five days. The council can dispose of the ordinance by the same majority as passed or rejected it originally and it can have its own way without action in case of defeated ordinances, since it acts at its "convenience," on the mayor's demand for reconsideration.

The charter commission will next work out the ordinance in detail and, presumably, give numerous public hearings. On completion, the document will go to popular vote in a general election.

Work Well Under Way on Pit No. 4 Power Project

Almost immediately after the completion last fall of plant No. 3 in the series of power projects being built by the Pacific Gas & Electric Co. on Pit River, Calif., work began on Pit River No. 4, the next project below and the fifth in this basin. Through the winter months a minimum of about 200 men have been on the work, the diversion dam has been built and it is expected that concrete in the main dam will be brought up above river level before the season is over. A description of the Pit 3 development appeared in *Engineering News-Record*, Jan. 28, p. 144.

The first step was to build the railroad down the river from Pit No. 3, a total extension of 10 miles being required to reach the new plant. The tunnel on the new project will be 19 ft. in diameter and 23,800 ft. long, of which about 21,000 ft. under a mountain will be driven from two headings only.

An interesting feature will be the dam located 2 miles downstream from Pit 3 power house at a point where rock foundation is available only on the right bank. To suit this condition the dam will be divided into overpour and non-overpour sections, the latter being probably of hollow type construction, by a concrete division wall 30 ft. thick. This wall, supported on rock, will have a total length of 200 ft. to keep the overpour on the rocky side of the canon. The maximum height of the dam will be about 60 ft. The diversion flume recently completed is of timber; it is 11 x 24 ft. in section and 1,600 ft. long, its lower end extending 900 ft. below the dam site.

Pit River No. 4 is to cost, exclusive of transmission lines, about $15,000,000 of which the dam calls for $1,750,000. The plant will contain three 40,000-hp. reaction turbines, operating under an effective head of 340 ft. The work is under the general direction of O. W. Peterson, chief construction engineer. P. M. Downing is vice-president in charge of construction.

Merrill to Attend Meeting of World Power Conference

O. C. Merrill, Executive Secretary, Federal Power Commission, has been designated by the U. S. Government as a representative to the special session of the World Power Conference to be held at Basle, Switzerland, simultaneously with the International Exhibition for Inland Navigation which is to be held there from August 31 to September 12, 1926.

The purpose of this special session is to give more careful consideration to certain economic and financial factors in the production of power than could be given at the 1924 World Power Conference. The points to be discussed are a utilization of water power and inland navigation; the exchange of electrical energy between different countries; the economic relations between electrical energy produced hydraulically and electrical energy produced thermally, and the utilization of electricity in agriculture.

Announcement of A. W. W. A. Program Buffalo, N. Y.

Sixty papers and topical discussions and a number of committee reports are listed on the program of the 46th annual convention of the American Water Works Association, to be held at the Hotel Statler, Buffalo, N. Y., June 7 to 11. Social functions, besides those designed for the ladies, include an opening reception and dance, a smoker and also a dinner dance, all given by the Water Works Manufacturer's Association; a dinner for members of the Water Purification Division; and the sixth annual "get-together dinner of the Service Des Eaux."

The Water Purification Division will hold three sessions, one parallel with a general meeting and two parallel with joint meetings of the two other divisions—Plant Management and Fire Protection.

A special train of Pullman and dining cars will run from New York to Buffalo via the Lehigh Valley Railroad, leaving New York City Sunday morning, June 6, and stopping at Newark and other main points en route. Checks for regular and sleeping car tickets on this train should be sent in advance to W. H. Van Winkle, president Water Works Equipment Co., 50 Church Street, New York City, from who also a train schedule and rates of fare may be obtained on application.

Programs of the convention will be mailed to members about May 1. Others may obtain copies from W. M. Niesley, assistant to the Secretary American Water Works Association, 170 Broadway, New York City.

Bill Reorganizing Public Works Dept. of New York Signed

The bill recently passed by the New York State Legislature for the reorganization of the Department of Public Works has been signed by Governor Smith. It becomes effective Jan. 1, 1927. The new department is to be headed by the superintendent of public works, who shall be appointed by the governor. The new department consists of five divisions: canals and waterways, highways, public buildings, engineering, architecture.

The heads of the divisions of engineering and of architecture shall be known as the state engineer and state architect. Both shall be appointed by the superintendent of public works.

Univ. of Wisconsin Establishes Research Fellowships

The University of Wisconsin, Madison, Wis., has established three new research fellowships in the College of Engineering. They are two-year appointments at a salary of $900 the first year and $1,100 the second. Candidates must be graduates of engineering colleges of recognized standing with preferably several years of graduate study, teaching, or engineering experience. In addition to assigned research topics there will be an opportunity to complete the work for an M.S. Degree.

Engineers as Executives Subject of Discussion

"Qualifying Engineers for High Executive Positions" was the subject considered at a joint meeting of the metropolitan sections of the Am. Soc. C. E., the A. S. M. E., the A. I. E. E. and the A. I. M. & M. E. held April 14 in the Engineering Societies Building, New York City. An audience of about 800 heard the speakers, Edwin M. Herr, president, Westinghouse Electric & Manufacturing Co., H. A. Guess, vice-president, American Smelting & Refining Co., Dr. F. B. Jewett, vice-president American Telephone & Telegraph Co., and J. C. Parker, vice-president and chief engineer, Brooklyn Edison Co., who approached the subject from various angles.

Mr. Herr considered the training of the students in engineering schools as a ground work for development of executive ability. "Too materialistic and technical an education is dangerous, but, on the other hand the colleges cannot build the necessary character and ability, unless the student has the required groundwork." Mr. Guess felt that although there were not as many engineers in executive positions as there were members of some other professions still as percentages of totals ran engineers were getting their due share of such positions.

Both Dr. Jewett and George J. Ray, chief engineer, Delaware, Lackawanna & Western R.R., who spoke in discussion, were of the opinion that many engineers either do not want to leave technical work or else are afraid of the responsibilities that an executive position entails. Mr. Ray said that the practice of the railroads varied greatly, some railroads advancing their engineers into all executive positions and others not considering them at all.

Mr. Parker said that if engineers were not recognized as material for high executive positions, they could, at least as a class, blame no one but themselves. S. H. Libby, consulting hoist engineer, General Electric Co., also spoke in discussion on the subject.

Demands on Reclamation Funds Outrun Available Supply

Demands for reclamation expenditures greatly exceed available moneys, according to a compilation by the Bureau of Reclamation made public recently. Demands for improvement and extension of old projects and for the construction of new federal reclamation projects total $106,000,000. The average annual income of the reclamation fund for the last five years has been about $8,500,000, but last year the receipts declined nearly $3,000,000 ($10,200,000 for 1925, $13,150,000 for 1924).

Twenty-five new projects and new divisions of old projects are being asked for. They are located in 10 Western States (6 in Oregon, $26,800,000; 2 in Wyoming, $16,060,000; 3 in Washington, $13,800,000; 3 in Idaho, $12,430,000; 11 in other states, from $10,000,000 for California to $2,225,000 for New Mexico).

Centennial of Oldest Railroad Charter Celebrated

The New York Central Railroad Co., on April 17, eclebrated the centennial of the granting of the charter of the Mohawk & Hudson Rail Road Co., the oldest unit of the present New York Central system. The railroad was to be built between Albany, N. Y., and Schenectady. Due to financial difficulties, construction was not started until about August 1, 1830, and the official opening took place on Sept. 24, 1831, when the DeWitt Clinton, a locomotive built at the West Point foundry, drew the first train over the new railroad.

The issue of the Mohawk & Hudson charter antedates that of the Baltimore & Ohio, which was issued Feb. 28, 1827, but the first steam operated train was run on the Baltimore & Ohio, Aug. 30, 1830, and the second train was on the South Carolina R.R. Jan. 15, 1831, when the Best Friend, the first locomotive built in the United States, to be put into actual service made its initial trip. Previous to this, on Aug. 8, 1829, the Delaware & Hudson Canal Co. had tried out the Stourbridge Lion, a locomotive built in England, but it was too heavy for the tracks and it was not put into actual operation. Still earlier, in 1825, John Stevens built and operated a locomotive on a circular track at Hoboken. However, it was never put into actual railroad operation.

Old Mill Dam Washed Out When Cut

A small mill dam at North Scituate, R. I., was washed out on April 13 under unusual circumstances. The dam, a structure 5 or 6 ft. high, built of dry stone facing enclosing sand fill, impounded 200 or 300 acre-ft. of water. It was cut by employees of the Providence water department in order to drain the reservoir. They had not been able to find the gates and believed that cutting the dam would be safe because of its low height. Flow through the cut got beyond their control, and made a large breach, sending a flood down the valley. A section of road was washed out and a considerable area of field submerged, but no lives were lost and no serious property damage was done. Some distance below the dam, the flow turned aside from the original brook valley at another mill dam pool, and cut a new channel on another alignment.

Syracuse Crossing Commission Becomes State Agency

The Syracuse Grade Crossing Commission has been constituted an agency of the State of New York under an act recently approved by Governor Smith. The present commission is confirmed and continued in office as commissioners under this act and is empowered to prepare plans, hold hearings, and otherwise arrange for the elimination of grade crossings in the city of Syracuse under the provisions of the recent amendment to the state constitution providing $300,000,000 for use in eliminating grade crossings.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Summer Meeting, Seattle, Wash., July 14-16; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION, Ann Arbor, Mich.; Annual Meeting, New York City, April 30, 1926.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, N. J., May 10-13, 1926.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Buffalo, N. Y., June 5 and 7, 1926.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., June 7-11, 1926.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Philadelphia, Pa., June 13-19, 1926.

SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, State University of Iowa, Iowa City, June 16-18, 1926.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J.; June 21-25, 1926.

INTERNATIONAL CITY MANAGER'S ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

The National Lime Association will hold its annual convention at French Lick Springs, Ind., June 8-11; the program will be announced later.

The Chamber of Commerce of the United States will hold its annual meeting in Washington, D. C., May 11-13; foreman training and the question of wages are two important subjects to be discussed.

A Polish Engineering Society has been organized in Detroit, Mich., with the following officers: Witold Kosicki, president; J. W. Skutecki, vice-president; K. Szymanski, secretary, and P. Kusiorski, treasurer.

Personal Notes

CHARLES GILMAN HYDE, consulting sanitary and hydraulic engineer, and professor of sanitary engineering at the University of California, Berkeley, Calif., has been appointed dean of men at that university.

ELSON HALE, for fifteen years principal assistant of the Parkes Engineering Co., Pine Bluff, Ark., has purchased the general engineering business of the company, and will continue the business under his own name at the same office.

L. P. O. EXLEY has been appointed chief engineer of the Gulf, Mobile & Northern R.R., at Mobile, Ala., and his former position as engineer of maintenance-of-way is abolished. He succeeds H. S. JONES, assigned to other duties.

THERON M. RIPLEY, for twenty years with the state of New York, has been transferrer at his request to the post of division engineer in Erie County, and will have charge, under the county engineer, of the preliminary and construction work incident to the building of a comprehensive highway system in the Buffalo district.

HAROLD R. KELLER, formerly lieutenant commander in the United States Navy and recently lubrication engineer and industrial sales supervisor for New England with the Tide Water Oil Sales Corporation, has joined Stone & Webster, Inc., and is now located in the office of the engineering manager at Boston, Mass.

P. W. SOTHMAN, consulting engineer, who was formerly chief engineer of the Ontario Hydro-Electric Power Commission, and later carried on consulting practice in Toronto and New York City, has been appointed technical adviser to the Irish Free State government for service in connection with the Shannon hydro-electric power project.

HUGH M. NELSON, Erie, Pa., recently chief engineer of the Erie Concrete & Steel Co., has resigned and has opened an office in Room 302 Scott Block, Erie, for general engineering practice in design of structural steel and reinforced concrete, industrial plants, buildings, garages, bridges, dams and similar structures.

F. W. HAZELWOOD, who has been acting chief engineer for Division 3 of the California State Highway Commission, has been appointed chief engineer for the division, with headquarters in Sacramento; Mr. Hazelwood has been in the service of the commission since 1912. E. Q. SULLIVAN, acting chief engineer of Division 8, has been made chief engineer of that division.

MAJOR RUFUS W. PUTNAM, Corps of Engineers, U. S. district engineer at Chicago, Ill., has been transferred to Honolulu, Hawaii. Major Putnam graduated from the U. S. Military Academy in 1913. He was in charge of the Military Survey Section of the office of the Chief of Engineers during the early part of the War, then served overseas with the 318th Engineers, as lieutenant colonel. From 1919 to 1921 he was executive officer at Camp Humphreys. In 1920 he was commissioned major, in 1921 assigned to Chicago as assistant to the U. S. district engineer there, and in December, 1921, made district engineer at Chicago.

J. R. WENDT, district maintenance superintendent of District 14, Louisiana Highway Commission, has resigned to become parish highway engineer of Bossier Parish, Louisiana, with headquarters at Benton; this parish has recently issued $1,630,000.00 bonds with which to construct highways. Previously Mr. Wendt was employed as highway engineer of Tensas Parish, and before that by the Mississippi River Commission as junior engineer.

EDWARD F. WEISKOPF and WALTER H. WEISKOPF have been admitted as members of the firm of Weiskopf & Pickworth, consulting engineers, specializing in structural design, 45 West 45th St., New York City.

MAJOR HERBERT J. WILD, Corps of Engineers, attached to the office of the Chief of Engineers, War Department, Washington, D. C., has been ordered to Chicago, Ill., for duty at headquarters of the 6th Corps Area, and LEONARD B. GALLAGHER, captain, Corps of Engineers, at Yale University, has been ordered to Washington to succeed Major Wild.

Obituary

E. F. WIEDERHOLDT, president of the Wiederholdt Construction Co., St. Louis, Mo., died April 13 at his home in Overland, Mo., of a cerebral hemorrhage; his age was 47 years. He was born in St. Louis and graduated in mechanical engineering from Washington University in 1901. The company of which he was the head has done much construction work in St. Louis.

GEORGE E. GIFFORD, vice-president of the Jobson-Gifford Co., contracting engineers, New York City, died April 14, at Maplewood, N. J., aged 62 years. After graduating in civil engineering from Rensselaer Polytechnic Institute in 1887, Mr. Gifford was connected with the King Bridge Co. of Cleveland, Ohio, in charge of the design and contracting department for a number of years; later, for the company he had charge of the construction of the Harlem Ship Canal bridge at Kingsbridge and the New York Central four-track bridge over the Harlem River. In 1908 and 1909 he was chief engineer of Milliken Bros., Inc., New York, and became secretary of the Bridge Builders' Society in 1911, which position he occupied until 1922.

PROFESSOR LOUIS A. HERDT, Macdonald professor of electrical engineering at McGill University, Montreal, and vice-president of the Montreal Tramways Commission, died in his office in the McGill Engineering Building, April 11; he had left the hospital a few days before and had been in ill health for some time. Professor Herdt was born in France 53 years ago, went to Canada and graduated from McGill University, gaining also a master's and doctor's degree. He then returned to France and engaged in research work at the Laboratoire Centrale and later in Liege, Belgium. In 1899 he was appointed to the position of demonstrator in electrical engineering at McGill and later became associate professor. He served in France during the War and received the decoration of the Legion of Honor.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Uniform Sales Contract for Reinforcing Steel

The Concrete Reinforcing Steel Institute, the association of the manufacturers, at its Atlantic City meeting last month, approved and adopted the uniform sales contract that had been prepared by its committee on standard practice after a careful and comprehensive study of the needs of the industry. Copies of this sales contract have been sent to all members of the Institute and the secretary states that it is now being put into universal use.

The use of this sales contract will provide purchasers in all parts of the country reinforcing steel under exactly the same terms and conditions. Also the careful manner in which the contract has been prepared gives assurance that all the usual grounds for disagreement between the buyer and seller have been specifically provided for in the general conditions of sale that are printed on the back of each contract form.

Measuring the Hiding Power of Paints

An investigation has been carried out at the Bureau of Standards of the Department of Commerce with the ultimate object of developing a method for measuring the hiding power of paints. Paints vary widely in their ability to conceal underlying surfaces, one paint hiding them completely in three coats, whereas three coats of another paint may still permit pencil marks or finger prints to be seen on the wood beneath. A photographic method has been developed in which the film thickness required for complete hiding can be determined even as close as one-seventh the thickness of an average thinly brushed paint coating. The hiding power as finally expressed is in terms of square feet of surface that 1 gal. of wet paint will cover and hide.

Business Notes

ATLAS LUMNITE CEMENT CO. has announced its intention of establishing a research associateship at the Bureau of Standards of the Department of Commerce. The establishment of this position will permit continuous experimentation and study of concrete proportioning and the effect of water on concrete of high alumina content.

RIX COMPRESSED AIR & DRILL CO., San Francisco, on Apr. 1 announced the reorganization of the company as the Rix Company, Inc. In conjunction with this change the capital stock of the company has been increased to meet the expanding needs of the business. Officials of the new organization are: E. A. Rix, president; Austin Rix, vice-president; M. L. Hewett, secretary and sales manager; R. W. Arns, director and manager, Los Angeles branch.

ROLLWAY BEARING CO., INC., Syracuse, N. Y., manufacturer of heavy duty roller bearings, announces the following changes in the personnel of its sales force: C. A. Call, formerly assistant sales manager, Gurney Ball Bearing Co., has been appointed sales manager; E. J. Lybert has been transferred from the Philadelphia district to a position in charge of the Detroit district; J. D. Firmin is representative in the Philadelphia district; W. E. Smith has been transferred from the home office to the Youngstown district.

LINK-BELT CO., Chicago, announces the opening of its branch office in Milwaukee, with R. C. Kendall in charge.

SANDERSON-CYCLONE DRILL CO., Orrville, Ohio, announces the purchase of the motor division of the Wellman-Seaver-Morgan Co., of Cleveland, Ohio, which was formerly operated at Akron, Ohio. All the physical property involved in the purchase has been moved to the new factory at Orrville, Ohio, where the engines are now being built and serviced. John Riise, formerly chief engineer responsible for the design and development of the W-S-M engines, now holds the same position with the Sanderson company. In addition, the shop superintendent, the foremen of the machinery, erecting and testing departments of the W-S-M Co. have also been employed by the Sanderson company. There will, therefore, be no radical changes in engineering and manufacturing policies affecting this engine, which is a four-cylinder four-cycle valve-in-head type developing 28 hp. at 600 r.p.m. up to 56 hp. at 1,400 r.p.m.

OXWELD ACETYLENE CO., New York City, announces the appointment of J. N. Walker as general sales manager. L. D. Burnett has been appointed eastern department sales manager to succeed Mr. Walker and Z. T. Davis, Jr., is now filling Mr. Burnett's former assignment as assistant sales manager of the eastern department.

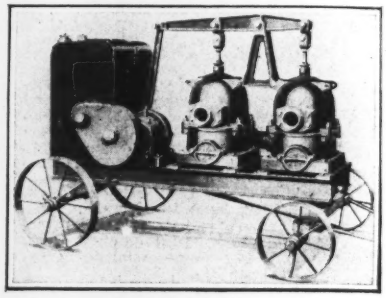
S. FLORY MANUFACTURING CO., Bangor, Pa., announces the appointment of the following distributors for their equipment: C. E. LaBoyteaux Co., Los Angeles, Cal.; Willamette Equipment Co., Portland, Ore.; Brown, Fraser & Co., Ltd., Vancouver, B. C.; General Machinery Co., Spokane, Wash.; Western Supply Co., Butte, Mont.; Engineering Products Co., Chicago, Ill.

MUNDY SALES CORP., New York City, announces the appointment of the Carbine-Harang Machinery & Supply Co., New Orleans, La., as its representative for the state of Louisiana. L. J. Breed, Chattanooga, Tenn., has been appointed representative for Mundy distribution in the Tennessee sales territory.

Equipment and Materials

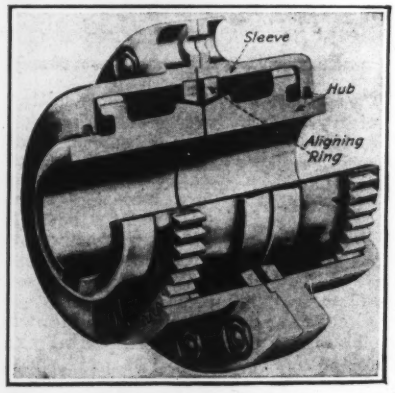
All Gearing Inclosed on New Diaphragm Pump

Since diaphragm pumps usually work under conditions not conducive to long life of wearing parts, the Novo Engine Co., Lansing, Mich., has developed a self-oiling speed reducing unit that completely incloses and protects all gearing on the company's diaphragm pumps. These pumps are powered by a Novo UF two-cylinder, 3-6-hp. engine.



Flexible Coupling for Use on Shaft-Connected Machines

A flexible coupling designed to compensate for the usual and unavoidable errors of shaft misalignment in all classes of connected machinery and to allow free end float to two connected shafts is a new product of the Poole Engineering & Machine Co., Baltimore, Md. The coupling consists of six parts, two hubs having an external gear on each, meshing with internal gears in two sleeves which are bolted together, and two aligning rings which are fitted in the two sleeves. The outer faces of the teeth on the hubs are formed spheri-



cally and provide a true self-aligning bearing for the connecting sleeve.

All parts of the coupling are made of high carbon forged steel. Oil holes are provided in one side of the coupling flange. When the coupling is running, the oil spreads out under centrifugal pressure so that the sleeve bearings and gear teeth are entirely submerged in oil. The couplings are always designed stronger than the shafts which they are to connect.

Jack Utilizes Governor Speed Control

The new jack manufactured by the Duff Manufacturing Co., Pittsburgh, Pa., is of the high speed type and utilizes a governor on its lowering speed. This governor is claimed to insure safety under all conditions. When two or more jacks are used together, the governor makes it impossible for one jack to lower more rapidly than the others, thereby eliminating any uneven settlement of the load. With this governor the jack may be slowed down gradually or stopped instantly at any point without shock or strain. There is only one pawl on the lever socket. In the first position the pawl will raise the load in the usual manner; the second position is neutral, and the third position is used for running the standard down without load.

A positive lock, which also acts as a brake when lowering the jack gradually, holds up the load. No dependence is placed upon springs at this important point.

A one-piece shell holds all the working parts and bearings in an integral unit. The standard is prevented from screwing out from under the load by the use of an oversized key. A positive stop at the base of the standard prevents extending the jack beyond the safe limit of raise. The rated capacities of the jacks available are 15, 25, 35 and 50 tons respectively. These ratings are claimed to provide an ample factor of safety.

Tie Lifting Cradle Operates From Boom Line

Employing the same principle that is used in the operation of the grab bucket, the tie lifter, manufactured by the Hussey Mfg. Co., North Berwick, Me., is designed to handle ties wherever large quantities must be moved.

The machine consists of two side plates fastened to the grapple arms. Just below the bottom of each side plate is a row of piston bolts mounted on heavy springs. The machine is lowered over the ends of the ties in an open position, after which the closing rope is taken up. This action closes the machine so that the piston bolts engage the ends of the ties as do also the side plates. From 40 to 50 ties can be moved in one load. Springs on the piston bolts permit a variation in length of ties of from 4 to 5 in.

The machine is 8 ft. 3 in. tall and

11 ft. 4 in. by 7 ft. in plan. It is made entirely of steel and iron and weighs 3,000 lb. It is designed to carry a load of 7 to 8 tons.

Air Hoist Designed for Use With Portable Compressor

Another example of the use of one power plant to operate several pieces of construction machinery all mounted in the same frame is afforded by the new air hoist manufactured by the Ingersoll-Rand Co., New York City, for use with its portable compressors. The hoist is thus available for the many small hoisting problems that present themselves on a moving job, and can use an existent power supply.

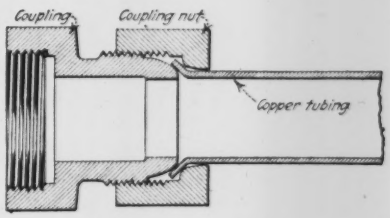
The hoist is of the winch type and may be attached to the rear end of a 5½x5 or a 5x5 portable compressor or to the sides of larger compressors. It is capable of exerting a rope pull of 1,000 lb. and of taking 350 ft. of ⅝-in. cable. A swivel bolt through the bottom of the base permits the hoist to be swung around into any desired position.

The hoist is provided with a clutch so that the cable can be played out by hand or by a downgrade load without turning over the motor and consuming air. A hand brake is used on the drum. The throttle control is very sturdy and sensitive, providing speeds from the very slightest movement up to a maximum of 65 ft. per min. The hoist weighs 250 lb. and is 25x15 in. in plan.

Copper Service Pipe Available With Flanged Fittings

For water supply both underground and through buildings, the Mueller Co., Decatur, Ill. has developed a thin wall copper tubing for use with flanged couplings. The tubing is made with plain ends, the purchaser spreading them with a flaring tool in applying the coupling nut. As shown in the illustration, the coupling screws into the coupling nut. These fittings are made of red brass.

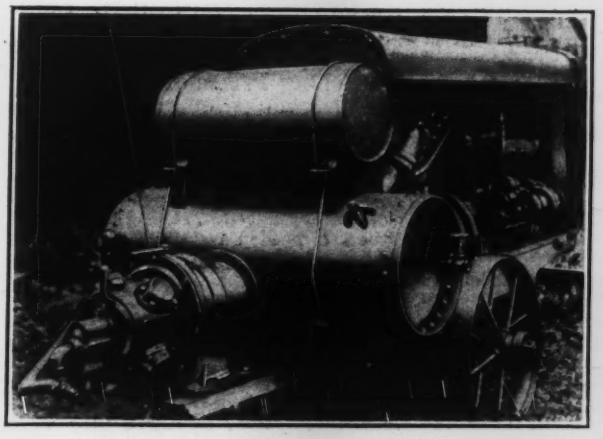
The thin wall provides a flexible tubing that is said to withstand more freezing and water pressure than some other forms of pipe. The main advantage claimed for this pipe by the manufacturer other than resistance to cor-



rosion is that screwed tube ends and jointing material are eliminated enabling the joint to be made in a minimum of time.

Water-Tube Walls Used in Place of Refractories in New Boiler

A type of boiler in which the area of the heating surface for a given output has been materially reduced, through exposing practically the entire heating surface to the radiant heat of the fire, has recently been announced by the Combustion Engineering Corporation, 43 Broad St., New York City. In addition to the reduction of heating surface for a given output, another important advantage of this type of boiler is the absence of refractories. The boiler consists of four drums, two at the top and two at the bottom, with interconnecting water tubes which form the walls, top and water screen of the furnace. The water is distributed from a steam drum at the top to the other drums by means of pipes outside of the boiler. The hot water rises from these drums through the wall-tubes to the steam drum again, completing the circulation. A burner is placed in each of the four corners of the furnace a short distance below the top drum discharging the burning pulverized coal



toward the center giving a turbulent action in the combustion chamber. From the point of combustion the flame and gases pass downward through a multitubular water screen, thence through a chamber to the superheater, and finally through the air preheater to the stack or induced-draft fan as the case may be.

The vertical tubes forming the four walls are of the fin type, that is, each tube has two longitudinal steel fins welded on it diametrically opposite each other; when placed in position the fins meet, thus presenting a continuous water-cooled surface to the radiant heat of the furnace.

Publications from the Construction Industry

CONCRETE SURFACE CORP., 342 Madison Ave., New York City, has issued a new pamphlet describing Con-Tex and the Con-Tex processes of surfacing concrete originated and developed by Nathan C. Johnson, consulting engineer. The booklet shows the results of the application of this surfacing material and gives the methods for the different types of use, namely, "standard," for a finished surface of exposed aggregate; "bonding," to produce a rough surface on which plaster, stucco or new concrete can be placed; "stucco," for stucco finish; and "special" for revealed aggregate in surfacing of roadways, floors, etc. The pamphlet concludes with an article by Mr. Johnson, entitled "Concrete and Its Characteristics in Commercial Work," which presents some novel views on the making of concrete.

Valves—LEAVITT MACHINE CO. features in its Catalog 23 the Dexter valve reseating machines. These machines are described and illustrated for globe, gate and pump valves and comprehensive lists of users in various industries are given.

Shovels—BUCYRUS CO., South Milwaukee, Wis., has issued a new bulletin describing its 120-B steam or electric 4-yd. full revolving shovel. Considerable space is given to details of the machinery both in text and illustration.

Asphalt Coating—THE FLINTKOTE CO., Pershing Square Building, New York City, has issued a small bulletin describing its asphalt emulsion which is applied cold and used as a protecting substance from water, acids, alkalis, and all corroding gases. It may be mixed with aggregate in highway work or applied to steel and wood with a brush and trowel.

Excavators—DAYTON WHIRLEY CO., Dayton, Ohio, has recently published a small booklet describing its Models 60 and 75 machines. These may be operated optionally by steam or electricity. Besides line cuts giving details and dimensions, a number of illustrations showing the equipment in use operating dragline and clamshell buckets are given.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Special Tabulation of Unit Prices

3. *Wood Block Paving*

The following unit prices were included in low bidders' estimates on various paving jobs from 1923 to date:

Project	Date	Sq. Yd.	Price per Sq. Yd.
Grade separation, Detroit, Mich.	Aug., 1923	1,400	$6.40
Bridge, Charleston, S. C.	Sept., 1923	572	3.75
Subway, Brooklyn	July, 1924	30	4.50
Williamsburg conduit of Catskill Aqueduct	Feb., 1925	600	4.00
Subway, Philadelphia	Sept., 1925	100	6.00
Subway, New York, Sec. 2, R-102	Feb., 1926	15,300	5.50

Next Week—Earth Excavation

Brick Supply Rising to Meet Active Demand

The quantity of unburned brick on hand, ready for the kilns, at yards throughout the country, is probably 72 per cent greater than the amount available at this time last year.

Fewer plants are closed down, consequently stocks of burned brick, shipments from yards and orders on books are all in greater volume than during the corresponding period in 1925.

Supply is just about even with demand, taking the country as a whole. In one district, embracing Kentucky, Tennessee, Mississippi, Alabama, Arkansas, and Louisiana, with no plants shut down, orders on books were 37.5 per cent in excess of available supplies, according to latest reports of the Common Brick Manufacturers Association of America.

Prices at yards range from $11.46 to $12.88 per M. as against $11.63 to $16.73 at this time last year.

The report of the Association issued Apr. 1, 1926 is as follows:

	Brick on Hand—Burned Thousand	Brick on Hand—Unburned Thousand	Brick Moved From Yards During Month Thousand	Orders on Books Thousand
1926				
Mar. 1	355,139	60,014	110,866	262,481
Feb. 1	324,203	58,399	108,688	259,158
1925				
Mar. 1	305,831	34,891	110,790	247,176

Missouri Adopts Novel Method of Selling Prison-Made Brick

An unusual method of disposing of brick produced by its convict labor has been adopted by the State of Missouri.

In purchasing supplies for the State Penitentiary the State Penal Board compels the salesmen selling the various products needed by the institution to agree in advance to take as part payment some of the brick made by the convicts.

The first step in this direction was taken on February 27 when bids were taken on two automobiles needed for the prison.

When the salesmen for various automobile companies appeared they were informed that the prison would turn in three old machines, pay part cash and expected the company getting the contract to take the balance of its pay in prison-made brick. The latter sum amounted to about $1,600.

One salesman got in touch with a local builder and found a sale for the brick, then closed the deal with the Penal Board for the two automobiles; he will take about 80,000 brick.

First Quarter Cement Demand 2 Per Cent Under Year Ago

The figures below would seem to indicate that there is nothing alarming in the cement situation. Lower production is offset by increased stocks. Shipments during the first quarter of 1926 are only 2 per cent less than in that period of 1925. The changes from month to month in 1926 compare with the activity in 1925. These per cent changes are as follows:

	1925			1926		
	Production	Shipments	Mill Stocks	Production	Shipments	Mill Stocks
Jan.	0	0	0	0	0	0
Feb.	— 7	+16	+13	— 9	+ 3	+9
Mar.	+34	+70	+ 3	+34	+62	+3

First Quarter 1926

Production	2,204,000 bbl. under 1925
Stocks	2,743,000 bbl. over 1925
Shipments	465,000 bbl. under 1925
Shipments	2% under 1925

With respect to other materials, steel production in the first quarter of 1926 was 12,450,000 tons against 12,153,000 in 1925. Lumber production for this period was 3 per cent ahead of 1925, with unfilled orders 14 per cent greater.

Thus far the midsummer slump remains a hunch, at least so far as the construction industry is concerned.

Canadian Contract Letting Gains

Engineering construction contracts awarded in the Dominion of Canada, Jan. 1 to Apr. 1, 1926, were more than two-and-a-half times greater in volume than those let during the corresponding period last year, according to *Engineering News-Record* statistics.

Power plant, pulp and paper mill and other industrial construction is responsible for the marked gain in total money value.

Projects definitely reported as proposed during the period in question, show a decline of 48 per cent from the volume recorded during the same months in 1925.

This situation with regard to work in the proposed stage may affect the contract total during the next three months, reducing it to a point nearer the 1925 level for the period involved.

The following tabulation shows the money value of Canadian contracts awarded and work in the proposed stage during the period Jan. 1 to Apr. 1, this year and last:

	Awarded	Proposed
1926	$22,954,000	$102,361,000
1925	8,943,000	195,406,000

Distribution of Steel Pipe Shown by States

Steel pipe definitely specified as to quantity and type reported in *Engineering News-Record* in 1925 totaled 1,680,700 lin.ft., estimated to weigh a minimum of 76,525 tons. Of this, 1,111,690 was for riveted or lock-bar pipe. Following is a summary by sizes:

Size in Inches	Riveted or Lock-Bar Lin. Ft.	Steel Lin. Ft.
4	.....	43,500
6	29,740	37,000
8	224,500	58,060
10	5,000	750
12	137,300	.....
14	167,000	79,000
16	7,250	6,700
24	189,720	.....
30	24,200	.....
36	104,350	22,000
42	26,990	.....
48	58,550	5,360
50 to 60	97,090	200,800
66	.....	15,840
Total	1,111,690	569,010

Distribution of Pipe Reports in *E.N.-R.* During 1925

CALIFORNIA
- Vallejo—22 mi. of 24-in. riveted or combination steel, wood or concrete.
- San Bernardino—1,150 ft. of 8-in., 10,000 ft. of 6-in., riveted.
- Moravia—19,740 ft. of 4- to 8-in. 14-gauge riveted steel.
- Vista—167,000 ft. 4- to 18-in. wrapped riveted steel.
- Vista—100 tons of 36-in. riveted steel.
- Oakland—38 mi. of 60- to 63-in. steel.
- Yreka—3,480 ft. of 10-in. 14-gage riveted.
- Terra Bella—5,300 ft. 12-in. riveted steel.
- San Andreas—5,300 ft. of 6-in. steel.
- Alhambra—1⅛ mi. of 16-in. steel riveted.

MASSACHUSETTS (Boston)
- 7,380 ft. of 56-in. lock bar, steel riveted or hammer weld.
- 200 ft. of 48-in. steel.
- 7,300 ft. of 36-in. lock bar or 38-in. riveted.

MINNESOTA
- Minneapolis—830 lin.ft. of 54-in., 892 ft. of 54-in. and 4,498 ft. 48- or 50-in., lock bar steel.
- St. Paul—800 ft. 60-in. steel.
- Minneapolis—riveted steel, $33,170.

MISSOURI (St. Louis)
- 8,300 ft. of 60-in. welded or lock bar or 62-in. riveted, 3,000 ft. of 48-in. welded or lock bar or 49-in. riveted.

MICHIGAN (Detroit)
- 21,200 ft. of 36- to 48-in. steel, lock bar or hammer weld.

NEW YORK (Long Island City)
- 30-in. steel mains, $581,760.

NEBRASKA (Omaha)
- 21,970 ft. of 48-in. lock bar.

NORTH CAROLINA (Greenville)
- 18 mi. of lock bar, steel or lock joint rein. con.

OHIO (Cleveland)
- 1,575 ft. of 48-in lock bar steel
- 3,800 ft. of 36-in. riveted steel.
- 15,750 ft. of 36-in. lock bar or other steel mains, 11,700 ft. of 36-in. steel and 5,000 ft. of 48-in. steel.

OKLAHOMA
- Mangum—40,000 ft. of 4-in. steel.
- Tulsa—25 mi. of 4- to 10-in. Matheson grout.
- Oklahoma—25 mi. of 12-in. welded.

OREGON
- Bend—67,000 ft. of 12- and 16-in. steel or wood.
- Sutherlin—8 mi. of 8- and 12-in. arc welded, dipped and wrapped.

PENNSYLVANIA (Philadelphia)
- 7,500 ft. of 36-in. steel.
- 2,800 ft. of 36-in. steel.

RHODE ISLAND (Providence)
- 1.6 mi. of 66-in. steel.
- 0.3 mi. of 48-in. steel.

WASHINGTON
- Seattle—13,160 ft. of 24-in. riveted steel.
- Auburn—2 mi. of 24-in. wood or steel and 2 mi. of 8- or 16-in. steel or c.-i.
- Seattle—2,583 ft. of 42-in. and 3,210 ft. of 42-in. lock bar.
- Port Angles—37,000 ft. of steel or wood stave.

CANADA—
- B. C., Point Grey—3,500 ft. of 4-in. 20,000 ft. of 6-in., 6,000 ft. of 8-in.

(*Continued on p. 674*)

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
April 22, 1926	$22,814,000	$43,763,000	$66,577,000
April 15, 1926	22,240,000	39,116,000	61,356,000
April 23, 1925	24,182,000	30,248,000	54,430,000
January 1 to date			
1926	282,761,000	552,561,000	835,322,000
1925	275,970,000	411,367,000	687,337,000

Unit Prices Bid on Road and Paving Materials

THE accompanying tabulation gives a comparison of unit bids recently received by the City of Buffalo, N. Y., for various road and paving materials.

The furnishing of bitumen for top-dressing on macadam roads is to continue until Dec. 31, 1926 and where the price is bid delivered and applied to streets, it refers to auto pressure distributors in lots of 1,200 gal. each.

Sand, grit and gravel are quoted per net ton. Medina stone is covered in all bids on paving stone and curbing. The job involves 300 sq.yd. of paving stone, 500 sq.yd. of dressed block stone, and 200 lin.ft. of 4-in. curbing.

The Buffalo Cement Co., Ltd., 110 Franklin St., Buffalo, bid $2.50 per cu.yd. on all sizes of crushed stone delivered at City yards or anywhere within the city limits and $1.60 per cu.yd. of 2,500 lb. f.o.b. the Cement Company's crusher.

Unit Bids on Road Materials, Buffalo, N. Y.

Bitumen for Top Dressing—Macadam Roads

Bid Received From	Address	Materials	Unit Price per Gallon
The Bison Oil Products Co.	Foot of Genesee St., Buffalo, N. Y.	Texaco No. 45 road oil or No. 55 surfacing material	$0.13
The Barrett Co.	40 Rector St., New York, N. Y.	Bitumen for top dressing, tank cars, 8,000 to 10,000 gal.	.103
		Barrels, carload lots	.161
		Barrels, less-carload lots	.201
		Delivered and applied to streets	.135
		Delivered to city storage tanks by auto tank trucks	.13
The Atlantic Refining Co.	260 So. Broad St., Philadelphia, Pa.	Tank cars, 8,000 to 10,000 gal.	.0709
		Wooden barrels, carload lots	.1339
		Wooden barrels, less-carload lots	.156
The Texas Co.	17 Battery Place, New York, N. Y.	Texaco No. 45 road oil in tank cars 8,000 to 10,000 gal.	.0781
		Texaco No. 55 surfacing material in tank cars, 8,000 to 10,000 gal.	.0748
Warner Quinlan Co.	Warners, N. J.	Montezuman bitumen in tank cars	.115
		Wooden barrels, carload lots	.1718
		Wooden barrels, less-carload lots	.1883

Sand, Grit and Gravel

Bid Received From	Address	Delivery Conditions	Unit Price: Gravel Mixed, per Ton	Gravel Washed and Segregated, per Ton	Grit, per Ton	Sand, per Ton
Buffalo Gravel Corp.	19 Hudson St., Buffalo, N. Y.	F.o.b. yards	$0.85	.....	$0.95	$1.10
		Delivered to city yards in truck loads	1.15	.....	1.25	1.40
		Delivered in 5-ton loads to various parts of Buffalo	1.15@1.75	.....	1.25@1.85	1.40@2.00
Seneca Washed Gravel Corp.	72 Pearl St., Buffalo, N. Y.	F.o.b. yards	.85	$1.10	.95	1.10
		Delivered to city yards	1.15	1.30	1.25	1.40
		Delivered by trucks to various parts of Buffalo	1.15@1.75	1.30@1.90	1.25@1.85	1.40@2.00

Paving Stone anl Curbing

Bid Received From	Address	Delivery Conditions	Unit Price: Paving Stone, per Sq. Yd.	Dressed Stone Block per Sq. Yd.	4-In. Curbing per Lin.Ft.
M. A. Ryan Sandstone Quarries	Albion, N. Y.	F.o.b. siding, Buffalo	$2.50	$2.94	$0.85
Albion-Medina Stone Co.	Albion, N. Y.	F.o.b. siding, Buffalo	2.70	3.00	1.00
The Quarry Supply Co.	Albion, N. Y.	F.o.b. siding, Buffalo	2.80	3.10	1.00
Benjamin F. Spire	24 Colonial Circle, Buffalo, N. Y.	.....	2.75	3.40	1.20

Weekly Construction Market

PRICES of building materials have shown a consistently downward trend since the first of the year in most of the important centers of distribution throughout the country.

At this time last year, however, a similar downward tendency was in evidence, which continued until August, 1925. From August of last year to January, 1926, the price movement in basic construction materials was upward, with the possible exception of October, 1925, at which time a drop in lumber and some of the minor materials caused a slight deviation from the course.

With steel, cement and brick fairly steady in all of the large cities, the present decline runs mainly to lumber and the smaller items on the basic building materials list. There is no general movement toward an upward trend in lumber prices and slowness is reported as prevailing in New York State, the Middle West and the Gulf region.

Steel pipe discounts were increased about one point in San Francisco and four points in Chicago during the week. Linseed oil at Minneapolis is down ½c. per lb. from the April 15 level.

The movement of building materials prices is in keeping with that of the general wholesale market for all commodities, which has shown an excess of declines for the past three months. This price depression has given rise to a slackening of production activities but without noticeable decrease in employment of labor. Buyers continue to guard against deflation by keeping limited reserve stocks of materials on hand. Bank debits reflect a large turnover of money in the current market; revenue freight loadings continue at record levels.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.40	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$3.75
Structural rivets, 100 lb.	4.50	3.50	4.75	3.50	3.75	4.65	5.00	3.75	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.30	3.38	3.00	3.25	3.77½	3.20	3.25	2.30
Steel pipe, black, 2½ to 6 in. lap, discount	48%	44.3%	53.6%	—55%	54.25%	36%	—39.1@52.2%	45%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@52.60	46.35	54.00	49.20@50.20	53.00	64.00	52.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.84	2.31	2.65	—1.42
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.25
Sand, cu.yd.	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	1.50
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.50	34.00	56.00	41.00	37.75	34.75	27.00	25.00	65.00
Lime, finishing, hydrated, ton	18.20	+23.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.25@2.75	1.50	1.85	2.25	1.35	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.50	10.50	11.10	12.00	14.25	12.00	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	— 0895	.10	.075	.....	.075	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1112	—.0895	.10	.075	.076	.075	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal.	.83¼	+.90¾	1.13	.85	—.93	1.06	.96	1.12	1.10
Common Labor									
Common labor, union, hour	.62½@.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.45@.55	.35@.50	.50	.50	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 62½c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of April 1, the next on May 6.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.15). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Distribution of Steel Pipe

(*Concluded from p. 673*)

750 ft. of 10-in. steel or wr. iron.
B. C., New Westminster—15 mi. of 14-in. steel.
B. C., Vancouver—32- and 36-in. riveted steel, $134,446; 14½ mi. 36-in.
B. C., Nelson—4,500 ft. of 10-in. French steel.
Ont., Toronto—gas mains, steel (22-in.) and cast iron, $500,000.

On April 1, 1926

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For Explanation and Details of Indexes Since 1913
See the First Issue of Every Month